THURSDAY, AUGUST 5, 1915.

A CHAPTER OF BRITISH SCIENCE.

Electricity in Gases. By Prof. J. S. Townsend. Pp. xv+496. (Oxford: Clarendon Press, 1915.) Price 14*s.* net.

THE present book was written to appear as the first of six volumes of a handbook on Radiology, to be published in German under the editorship of Prof. Erich Marx. The translation of Rutherford's "Radio-active Substances and their Radiations" appeared nearly two years ago as the second volume of the series. The other volumes in preparation deal with kathode rays, X-rays, photoelectric effects, and the theory of electrons and X-rays. It was intended that the last two subjects should be treated by a number of well-known physicists, including Profs. H. A. Lorentz, P. Zeemann, Langevin, Einstein, Riecke and Sommerfeld. No doubt the publication of the later volumes has been delayed by the outbreak of war.

The best-known work on the passage of electricity through gases is Sir J. J. Thomson's treatise, of which a second edition was published in 1906. This gave a very complete account of the work up to that date in this new department of physics. Since that time the growth of experimental facts has been so rapid that it would be difficult to treat the whole subject adequately within the compass of a single volume. Fortunately a number of small books have been published from time to time dealing with special topics, *e.g.* H. A. Wilson's "The Electrical Properties of Flames and Incandescent Solids," Townsend's "Ionisation by Collision," Sir J. J. Thomson's "Positive Rays," Kaye's "X-Rays," W. H. and W. L. Bragg's "X-Rays and Crystals," Crowther's "Molecular Physics," and Soddy's "Chemistry of the Radio-Elements." These have proved of great value and interest in giving a first-hand account of recent advances of our knowledge in these special departments.

The present volume is mainly confined to a discussion of the properties of ions and the mode of conveyance of electricity through gases. The allied subjects of radio-activity, characteristic X-radiations, wave-lengths of X-rays, and thermionics, receive only passing mention, as they were to be treated in detail by other writers in subsequent volumes. After a preliminary discussion of the methods of production of ions in gases by different agencies, there follows a detailed discussion of the motion of ions in the electric field, the laws of their diffusion and recombination, and the methods of determining the ionic charge. The latter includes an interesting account of the experiments of Perrin. Then follows a very complete discussion of ionisation by collision—a subject which the author has made peculiarly his own. Other chapters are devoted to the discussion of the conditions and types of discharge between conductors of various shapes, and the passage of electricity through vacuum tubes. The final chapter gives an interesting review of the pioneer researches on the nature of the kathode and positive rays.

Our information on the subject of ionisation and the passage of electricity through gases has grown so rapidly, and is in many respects so definite and complete, that the reader is liable to forget how modern the subject is, for the whole advance is included within a period of less than twenty years. It is instructive to note what a prominent part British science has taken in its development. Practically all the pioneer discoveries in this subject were made in the Cavendish laboratory, and it is of interest to recall briefly the more important features in this advance. Shortly after the discovery that X-rays imparted a transient electrical conductivity to gases, in 1896 J. J. Thomson and Rutherford showed that the results were simply explained on the assumption that the current through the gas was due to the movement of charged ions produced throughout the volume of the gas by the radiation. This theory was soon generally accepted, and has formed the starting point of subsequent advances. Then followed the work of Rutherford on the recombination of the velocity of ions and the application of the ionisation theory to radio-activity. Zeleny discovered the difference in velocity between the positive and negative ion, and made the first accurate measurements of the mobilities. To this period belong the classical researches of C. T. R. Wilson on the ions as nuclei of condensation—investigations which have had such a remarkable development in recent years in making visible the processes occurring in the ionisation of gases by different types of radiation. Then followed the application of the ionisation theory to explain the conductivity of flame gases and flames by J. McClelland and H. A. Wilson, and later the investigations of H. A. Wilson and O. W. Richardson on the escape of negative electricity from glowing bodies.

We can only refer in passing to the pioneer experiments of Townsend, J. J. Thomson, and H. A. Wilson on the magnitude of the charge carried by the gaseous ions. In 1898 Townsend began his well-known researches on the diffusion of ions, and on the ionisation of gases by collision

—investigations which have had important consequences in many directions. Not only did the Cavendish Laboratory take a prominent part in the earlier discoveries, but many of the important later contributions in this subject have been made either by the students in that laboratory or by those who had come under its influence. In this review, however, we must not omit to mention the earlier contributions of Perrin and Sagnac, and the important theoretical and experimental investigations of Langevin, who for a time was an advanced student in the Cavendish laboratory.

The present volume is a very lucid and admirable exposition of our knowledge on this subject. The various theories which have been proposed and the experimental data are analysed with critical skill, and there are numerous original calculations added by the author himself. The mathematical theory of the subject is worked out with considerable detail, but is controlled at all points by careful consideration of the experimental data. The theory of the relation between current and voltage for ionised gases is mainly confined to the case of uniform ionisation, which, as is well known, presents many mathematical difficulties. No mention is made of the interesting cases that arise when the ionisation is non-uniform, or mainly confined to one electrode. Such cases often arise in experimental work, and it is important to direct the attention of the student to the marked differences in the current-voltage curves which are exhibited under different conditions of distribution of the ionisation. While the author does not profess to discuss the whole of the large number of papers that have been published in this field, a clear account is given of all the more important investigations, and great care has been taken in the numerous references to literature. It is probable that many of those who have followed closely the rise of this subject will not in all cases agree with the relative importance tacitly assigned to practically independent investigations in this field; but this, after all, is largely a matter of personal opinion. We can strongly recommend the present work as a sound and valuable contribution to our knowledge of the development of a very interesting and important branch of modern physics.

E. R.

THE PRINCIPLE OF RELATIVITY.

The Principle of Relativity. By E. Cunningham. Pp. xiv+221. (Cambridge: At the University Press, 1914.) Price 9*s.* net.

EVEN to the present day, the existence of the Principle of Relativity, which arose as a branch of physical theory, is somewhat trouble-some to the individual physicist, owing to the efforts of his philosophical friends to obtain a precise account of its origin, treated from an historical point of view, which can emphasise the exact movement of thought leading to its adoption. The literature of the subject has been scattered in various periodicals, and so loaded with mathematical symbols that its appeal has been to a very limited audience, in spite of the real simplicity of all the ideas concerned. Three recent volumes will serve to remove this difficulty very effectually, and two of them possess the advantage of proceeding from entirely different points of view. The first, by Dr. Robb, has already been noticed in these columns, and the second is the volume by Mr. Cunningham now under review, which is designed to fill the gap specially indicated in our first sentence. The third, by Dr. Silberstein, already noticed also, is similar to Mr. Cunningham's, but is based on a different mathematical treatment.

Mr. Cunningham's intention throughout has been to consider those aspects of the Principle which have a direct bearing on the practical questions of physics, without more recourse to mathematics than is absolutely essential for a really valuable consideration of these questions, and it may be said at once that the simplicity of the treatment is remarkable. The matter is put in a very interesting way throughout, and even to the non-mathematician the volume is not difficult to read. The first part gives a very lucid outline of the manner in which the Principle grew out of electrical theory, and one feature which must be recorded with satisfaction is the accuracy of the account, which does not share a tendency, noted in the case of several writers, to bestow too much of the scientific credit for the Principle on those who have worked out the details, at the expense of the real originators, one of whom belongs to this country. The space devoted to any problem is strictly commensurate with its importance.

The author makes it clear in this section that there is a place for the Principle as a hypothesis supplementary to electrical theory, and on account of the necessary limits of that theory, independent of it. He avoids, at the same time, excursions into questions with metaphysical bearing.

In the second part of the work an excellent account of Minkowski's two representations is given. The four-dimensional world of Minkowski is by far the most interesting development of the Principle, and, unfortunately, hitherto the most inaccessible in this country. This section is undoubtedly the most valuable part of the book for the general reader, and although it is essentially mathematical, the author has minimised the diffi-

culties as far as possible. Proofs of statements are printed in smaller type, and the general argument can be followed quite readily. Misconceptions of the position of the exponent of the Principle are frequent, and the exponent is not always free from blame. In these circumstances we welcome the explicit statement on p. 117—and the statement cannot be criticised—that while the Principle of Relativity cannot say what *are* the equations for bodies the motion of which is not uniform, it can say what they *may be*, and it therefore gives a powerful means of devising such equations to be tested by experiment. A similar definiteness is found in connection with the vexed problem of rotation.

The third part of the work is devoted to the necessary modifications of mechanical theory, on the supposition that the Principle is universal. Fundamental points only are dealt with, to the welcome exclusion of a mass of material the interest of which is almost entirely academic. Very speculative developments, such as that of Einstein in connection with gravitation, are omitted, and the author is thereby enabled to give a very clear view of the real implications of the Principle.

THE DEVELOPMENT OF MAN.

Heredity and Environment in the Development of Men. By Prof. E. G. Conklin. Pp. xiv + 533. (Princeton: University Press; London: Oxford University Press, 1915.) Price 8*s.* 6*d.* net.

ADDRESSING a general audience rather than a scientific gallery, Prof. Conklin deals in six lectures with the development of Man. In the first chapter he shows that development is the result of intrinsic factors, implied in the organisation of the germ-cells, and of extrinsic factors, the environmental conditions. The germ-cell is a living individuality, and development is one of its functions. New materials and qualities appear in increasing complexity, and this is due to active combinations and interactions under environmental influence. The hereditary germinal organisation is very complex, but development is no mere unfolding or unpacking. It includes processes of "creative synthesis."

The second chapter is devoted to the germ-cells and their organisation. "Development is progressive and co-ordinated differentiation of the germinal organisation, by which it is transformed into the adult organisation." Different kinds of substances are formed epigenetically; these are localised and isolated by intra-cellular movements and differential cytoplasmic divisions; and they are eventually transformed into various permanent structures.

The third chapter deals with the modes of inheritance, with special reference to Man. "Blending" is still retained on trial, but it is shown that "the principles of Mendel have served as an Ariadne thread to guide science through the maze of apparent contradictions and exceptions in which it was formerly lost." In the next chapter the author treats of the influence of the environment, and is more than usually careful in his analysis. He distinguishes the different kinds of developmental stimuli, the different times of their operation, and their varied results. There is a useful recognition of functional activity as a factor in development. "Nurture," it is argued, means much as a condition of individual development, but little as a transforming factor in evolution. For Man, however, with his social heritage, the evolution of the environment must corroborate eugenic improvements of the breed. In this and in the next chapter, which is devoted to a consideration of eugenics, the author turns repeatedly to the idea that environmental changes, saturating into the germ-cells, may incite heritable variations in the germinal organisation. The discussion of eugenics is restrained and wise. It is possible to improve the human breed (1) by preventing the seriously defective from reproducing; (2) by cultivating pride of race, and discouraging voluntary infertility on the part of those who have a goodly heritage; (3) by increasing opportunities for early and favourable marriages; and (4) by carefully conserving the best human mutations or heritable variations. But along with these eugenic endeavours there must go improvements of environment and training—including, pre-eminently, the development of control and goodwill.

In the concluding pages Prof. Conklin explains how he, as a biologist, finds between the fatalistic and voluntaristic extremes a middle way which leads to action. We venture to commend the wise and stimulating discussion of the determinism involved in the creature's hereditary and nurtural relations and of the other side to this. The book is marked by sound judgment, firmness and clearness of treatment, and a vigorous buoyancy. It is to be strongly recommended to those who wish to understand the facts of human development in their relation to the larger problems of human life. The volume is well got up, effectively illustrated, and provided with a carefully selected bibliography and an unusually good glossary as well as a full index.

MATHEMATICAL CRYSTALLOGRAPHY.

An Amateur's Introduction to Crystallography (from Morphological Observations). By Sir W. P. Beale, Bart. Pp. vii+220. (London: Longmans, Green and Co., 1915.) Price 4*s.* 6*d.* net.

THIS exposition of crystallography has been written by "an amateur" with the intention to help "other amateurs." Amateurs differ, however, very widely in the variety and extent of their interests and also in their keenness. The author has evidently had a mathematical training, and it is this aspect of the subject that specially appeals to him. Very few amateurs, such as those possessing a collection of minerals, would, we imagine, be anxious to begin by calculating the axial ratios of their crystals. They would rather wish to gain some insight into the general relations of the external forms and symmetry of crystals; and they would be repelled by pages of mathematical discussion and formulæ. Having produced such a work on crystallography, the author must no longer regard himself as a mere amateur, but as a serious crystallographer. For these reasons the book cannot be recommended to amateurs; it should, in fact, be carefully kept out of the reach of anyone who displays the slightest curiosity respecting crystals, otherwise the spark will surely be extinguished. On the other hand, the book will be of real value to the serious student who has already made some start in crystallography, for it will present the subject to him in a somewhat different light from that given in the ordinary text-books; and taking the two together the subject will no doubt be studied more intelligently.

The author plunges into his theme by regarding a crystal as a geometrical polyhedron, and selecting three edges as axes of reference, he explains clearly how the positions of all the other surfaces of the solid are fixed in terms of the Millerian system of notation. Commencing with the most general (and difficult) case, namely that of the anorthic system, he leads the unfortunate reader through the maze of spherical triangles necessary for the calculation of the angles of inclination and the relative lengths of the axes of reference. The remaining systems of crystals are logically treated in turn, ending with the cubic. Here the important idea of symmetry is only incidentally touched upon. This is, however, treated rather more fully in the succeeding description of the merohedral forms belonging to each system. There is a long appendix on methods of calculation, and another on the drawing of crystals from the calculated elements.

The 136 illustrations (several of which are repeated for convenience of reference) are a special feature and are entirely original. These are well and clearly drawn, and the method of giving the axes of reference in red adds still more to their clearness. There is a slight slip in fig. 64, whilst fig. 65 is quite wrong. The book is clearly printed in large type, and there are but few misprints; {*hko*}, etc., instead of {*hko*}, etc., however, recurs throughout the volume.

L. J. S.

OUR BOOKSHELF.

The Medical Annual. A Year Book of Treatment and Practitioner's Index. Thirty-third year, 1915. Pp. cxx+830. (Bristol: J. Wright and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1915.) Price 10*s.* net.

THIS, the thirty-third annual issue of this publication, contains a summary of the year's (1914) contributions to medicine and surgery by a number of competent authorities. The exceptional lateness of the isue is accounted for by the strain and distraction of a great war, all the contributors, fully occupied as they are in normal times, having been working under exceptional stress from military duties and contingent work. The list of contributors is a sufficient guarantee of the accuracy and up-to-dateness of the information given. Thus we find an account of the latest work on typhus and cerebro-spinal fevers, both of topical interest at the present time. Trypanosomiasis is dealt with by the competent hand of Sir Leonard Rogers, and the article gives full information of the latest work on the parasitology and treatment of this important condition. About twenty pages are devoted to the important subjects of radio-activity, X-rays, and electro-therapeutics, and useful sections deal with the changes in the new British Pharmacopœia of 1914. Special articles on naval and military surgery are included, together with references to personal experience in the treatment of wounds. A number of full-page and other illustrations are included, and form a special feature of the volume; they illustrate various disease conditions, details of surgical technique, surgical appliances, pathological features, etc. The two plates of skin eruptions in pellagra are beautiful examples of colour photography. The "Medical Annual" is a book eminently suited to the needs of the busy practitioner who desires to keep abreast with modern progress.

Wisconsin Geological and Natural History Survey. Bulletin No. xxxiv. Economic Series, No. 16. Limestone Road Materials of Wisconsin. By W. O. Hotchkiss and E. Steidtmann. Pp. viii+137. (Madison, Wis.: Published by the State, 1914.)

THIS bulletin has been published for the purpose of helping to conserve the expenditure of the "vast

sums" now being spent upon the roads of Wisconsin. For the years 1907–1911 the appropriation by the State for highway purposes was 2000*l.* per annum, in 1912 it was 80,000*l.*, in 1913 170,000*l.*, in 1914 it had risen to 246,000*l.*, and these figures represent less than one-third of the total amount spent on State-aided roads in the corresponding years. It must be remembered, however, that ten years ago there were practically no stone roads beyond the town boundaries.

The scheme of the report is excellent: part i. is a short introduction to the characters of the available road stones and to the methods of testing; part ii. deals with limestone, which appears to be the most convenient stone for use on the roads. The quarries in each county are described separately, and county maps show the distribution of the stone and quarries. Tests for each quarry were made by the Office of Public Roads (U.S. Department of Agriculture), part of the cost of which was borne by the State Highway Commission. The report of necessity possesses more local than general interest, yet it might well be taken as a model by the Geological Survey of Great Britain, which mentions quarries in a casual way in its memoirs, but has not yet produced one in which all the facts relating to a single important branch of the quarry industry are readily accessible.

Staffordshire. By W. B. Smith. Pp. xi+155. (Cambridge: At the University Press, 1915.) Price 1*s.* 6*d.* net.

In dealing with a county which includes two great manufacturing areas, an author might have been pardoned for giving an emphasis to the industrial character of Staffordshire, and for dwelling at length on the conditions which make Staffordshire the third county in industrial importance. Mr. Smith, however, has wisely balanced the more prosaic and unlovely areas against the beauty spots, such as Dovedale and the Moorlands, and the grimy factories against the fairer farms and the charming parks. The reader is introduced to dales comparatively unknown outside the county, to isolated items of interest such as the wild goats in Bagot's Park, and the Horn Dancers of Abbots Bromley. Those who have some acquaintance with Staffordshire will find much that is new in this book, which maintains the high standard of the series.

Catalogue of the Books, Manuscripts, Maps, and Drawings in the British Museum (Natural History). Vol. v., SO—Z. Pp. 446. (London: Printed by Order of the Trustees of the British Museum, 1915.) Price 20*s.*

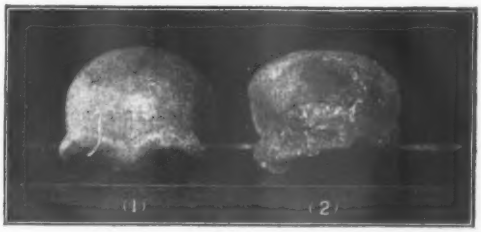
This volume of the catalogue of the collection of books, maps, and drawings in the Natural History branch of the British Museum brings the series of entries under the authors' names down to the end of the alphabet. The plan of the catalogue is that of the previous volumes, and was described when these were noticed in these columns.

LETTERS TO THE EDITOR.

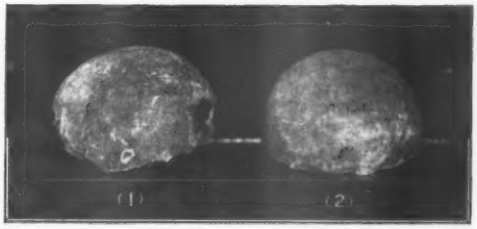
[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Palæolithic Man in South Africa.

In November of 1913 Mr. J. L. Groenewald, a farmer, of Adelaide, C.P., showed me some pieces of fossil bones, explaining that he had obtained them from a friend's farm at Boskop, in the Transvaal. He wanted my opinion as to whether they were human or not. I pronounced them to be portions of a human skull-cap of some very ancient race, and prevailed upon him to give them to me. A subsequent examination, after the parts had been fitted together and measured, made it clear that it was of a race as



Front view of the two skull-caps. (1) Neanderthal; (2) Boskop.



Back view of the two skull-caps. (1) Boskop; (2) Neanderthal.

Side view of the Boskop skull-cap, in comparison with the typical Neanderthal skull-cap. (1) Boskop skull-cap; (2) Neanderthal skull-cap. The forehead parts face outwards.

ancient, or more so, than the Neanderthal or the La Chapelle man. It bears a close resemblance in shape, thickness, and measurements to the former. The skull is as completely fossilised as the Karoo fossil reptiles. That it is of vast antiquity is certain.

This Boskop man differs from the typical Neanderthal type in having a lesser development of the

frontal sinus, and a somewhat greater development of the forehead. This would indicate that the Boskop man was of the Neanderthal race, but more advanced in intelligence than the type specimen.

The discovery of this skull offers an explanation of the origin of the Palæolithic implements which are scattered in such vast profusion all over South Africa, and should it prove to be of the true Neanderthal race, as I have absolutely no doubt is the case, we then possess evidence that this remotely ancient type of man migrated into South Africa, and if we conclude the stone implements with which the country is strewn are his handiwork, then he must have existed here in large numbers.

Mr. Piet Botha, the owner of the farm on which the skull-cap was found, readily granted permission for me to excavate. I excavated the site of the find in person, and discovered portions of a rib and collar-bone, part of the mandible with a tooth in it; some more fragments of the skull, and a few roughly chipped stone implements. The remains were found at a depth of 6 ft. in alluvial gravel. On application, the South African Royal Society subsequently made a grant to this museum of 100*l.* to carry on further excavations. The result was disappointing, a small portion of a human thigh-bone being the only result of this more extensive excavation.

The skull-cap and other remains are now in the temporary possession of Dr Peringuéy, of the South African Museum, where a careful and detailed examination is being made, but which cannot be completed until various data and measurements are procured from Europe. The first report will appear in the Journal of the South African Royal Society.

F. W. FITZSIMONS.

Port Elizabeth Museum, Port Elizabeth,
June 30.

MR. FITZSIMONS'S letter is the first authentic account published in Europe of the discovery of ancient human remains at Boskop Farm in the Transvaal. There can be no mistake about the importance of the discovery; the remains of Palæolithic man have at last been found in South Africa. As regards the nature or race of the individual thus found there is room for doubt; an examination of the photographs of the skull-cap reveal none of the characteristic features of Neanderthal man; one can exclude that race with some degree of certainty. The individual to whom the skull-cap belonged was apparently of the modern type, with a head of remarkably large dimensions. European and American anthropologists look forward with great interest to the publication of a detailed account of the Boskop discovery. ARTHUR KEITH.

Surface Tension and Ferment Action.

THE correspondence in NATURE of June 17 and July 22 by Dr. Cramer and Drs. E. F. and H. E. Armstrong on the possibility of the enzymic action of invertase being limited by surface tension, has led me to look up the laboratory records of some experiments which I made in 1892 on a cognate subject. I was at that time engaged in studying the formation of starch granules in various parts of the living plant, and the subsequent dissolution of the granules under the action of the cell enzymes.

In the course of this inquiry I came across a curious fact which suggested that the action of the diastatic enzyme is to some extent dependent on physical conditions existing at the limiting surface of the starch granule and its surrounding medium. Briefly stated, this fact is as follows.

If we mix with a dilute cold-water extract of malt a little solid starch of a kind which is readily attacked by diastase, *e.g.* that from buckwheat or barley, a microscopic examination will generally indicate a very appreciable erosion and partial disintegration of the granules within twenty-four hours, the actual time depending on the initial concentration of the enzyme. If a parallel experiment is so arranged that, with all other conditions remaining the same, the starch granules are kept in suspension by the addition of about 3 per cent. of gelatine, then we invariably find that the rate of erosion and dissolution of the starch is very much accelerated. This difference is also found to occur even if the mobile liquid which contains no gelatine is kept in continuous movement by mechanical means.

It appeared to me that very possibly the lowering of the surface tension of the liquid by the gelatine had enabled the large-moleculed diastatic enzyme to penetrate the granule with greater facility, and since the starch granules in plant-cells are suspended in highly colloidal protoplasm we might here have some sort of explanation of their rapid disappearance under the influence of very small amounts of active enzyme.

Reasoning from these facts, I drew the conclusion that in a given mixture of starch and enzyme we ought to find a diminution in the rate of erosion in those parts of the liquid which are in a state of tensile stress.

My first experiments in this direction were made in a flattened thermometer tube with an elliptical bore having a major axis of 0·4 mm. and a minor axis of 0·2 mm. The bore of the tube was charged with the diastatic liquid containing the starch-grains, which could be kept under microscopical observation through the walls of the tube. Under these conditions, the starch granules invariably showed a much higher resistance to erosion than did those of the same liquid contained in a small flask or beaker under similar conditions of temperature. At first sight this experiment gave some support to the idea of surface tension playing a part, but in a variation of it in which I used a thin film of the starch mixture between two inclined glass plates, I could find no difference in the rate of erosion in layers varying in thickness from 0·3 mm. downwards.

I then proceeded to investigate the action when the starch had been deposited in the interstices of porous substances, and in the first place used glass-wool, which was one of the substances employed by Messrs. Beard and Cramer, as described in their recent paper in the Proceedings of the Royal Society (vol. lxxxviii., ser. B, p. 575), on surface tension and ferment action. Under these conditions the erosion even of buckwheat starch, which is the most sensitive to action of this kind, *was entirely inhibited*, no matter how long the reaction was allowed to continue. For a short time I was misled by this result, and it was only after I had recognised the distinct alkalinity of the solutions which had been in contact with the glass-wool that I found the *causa causans* was of a chemical and not of a physical nature. Diastase, like invertase, is extremely sensitive to traces of alkali, and can only exercise its maximum effect in a slightly acid medium.

I satisfied myself that this was the true explanation by substituting for the glass-wool in the last experiment other porous substances, such as asbestos, cotton-wool, and filter paper, when the whole of the inhibitive effect disappeared. Thus failed my attempt to link enzymic action with surface tension, and even the original phenomenon with which I started, the apparent enhancing effect of a colloid like gelatine, admits of a different explanation based on the slightly acid reaction of the commercial product. It is now well

known that an amylohydrolytic agent, such as a malt-extract, is increased in activity by the addition of traces of acid sufficient to convert the neutral into the acid phosphates.

I believe that most scientific workers have, like myself, a scrap-heap of failures which may repay a little digging now and then. In the light of the recent discussion in your columns these few potsherds which have been recovered from the overlying débris of years may at the present moment have something more than a mere antiquarian interest.

HORACE T. BROWN.

52 Nevern Square, Kensington, S.W., July 24.

The Cancer Problem and Radio-activity.

PROF. JOLY, in an address published in NATURE of June 10, has given some more facts in connection with the theory associating radio-activity with the cause of cancer; and his endeavour to extend the theory so as to connect some of the commodities which predispose the tissues to the disease will be read with interest by those engaged in cancer research. But there are other such commodities which Prof. Joly has not apparently taken into consideration, especially arsenic and manure; and he is not correct when the attributes "sweep's cancer" to mechanical irritation.

The last point was demonstrated at the recent Home Office inquiries on pitch ulceration and cancer, in association with which extensive research has been made at the John Howard McFadden Laboratories. It appears that there are two forms of pitch, the blast-furnace variety produced at a lower temperature mostly from Scottish coal, and the ordinary gas-tar variety made from bituminous coal. Both varieties are similar in consistency, and both cause similar mechanical injury; yet blast-furnace pitch is harmless, whereas gas-tar pitch gives rise to a considerable incidence of warts and sweep's cancer. Coal-dust may cause mechanical injury amounting to laceration; yet it causes no cancer. Soot, being soft and floury, does not mechanically irritate the skin, yet it occasions in sweeps more cases of cancer than in any other trade. Tar and some of the petroleum fractions are liquids, and cannot cause mechanical injury; yet they both are sources of skin epithelioma.

These commodities evidently give rise to the disease owing to the presence of some chemical agent contained in them, for the more they are concentrated the more disease do they cause. Coal causes no cancer; tar, the residue after the first stage of its distillation, causes some cases; pitch, the residue of the distillation of tar, causes such an incidence as to necessitate two official inquiries; and soot, the last residue of the carbonisation of coal, tar, and pitch, causes the most cancer among occupied males. The question is what is the substance that is being concentrated, and how does it act?

The researches which have been made on this subject are based on the fact that many classes of cells can be made to divide in response to auxetics—chemical agents which contain the amidine or amino groupings. This has been shown now with many classes of cells, including human cells; and Cropper and Drew have recently found that amœbæ, when isolated from other living organisms and placed in pure water, will not divide at all without the addition of an auxetic. Auxetics are physiologically set free in a tissue as the result of cell-death caused by injury; and when they are inoculated into certain tissues can be made to give rise to benign tumour formation, both in men and animals. There is another group of substances (including most of the alkaloids, choline, cadaverine, etc., to some of which Prof. Joly refers) that increase the action of auxetics very considerably. They have been called augmentors.

Since auxetics cause benign cell-proliferation—which is a very favourable condition for the onset of cancer, a large number of the coal-tar commodities and fractions were tested for auxetics by trying watery extracts of them on human cells. The commodities were sent to the laboratory by the authorities distinguished by numerals only; some were known to cause cancer, others were known not to do so; but the workers who made the tests were unaware as to which were which until the tests were complete. In this way it was ascertained that, by the simple test for auxetic or augmentor, those commodities (about 20) which give rise to cancer can be picked out from a large number (about 150) of those which do not.

Hence it is more than probable that the commodities act by virtue of the auxetics or augmentors they contain; the successive fractional distillations of coal, concentrating the auxetic in each stage, causes a higher and higher incidence of cancer, until the ultimate production of soot with the highest incidence of all (chimney-sweep's cancer).

Since then, all the other commodities which cause cancer, such as arsenic, manure, betel nut (a putrid mixture of areca and tobacco), tobacco and its smoke, "khangri" charcoal, some aniline dyes, and petroleum, have been tested, and all contain auxetic or augmentor. On the other hand, the harmless blast-furnace tar and pitch and the hard Scottish coal whence they are derived contain either no auxetic or augmentor or only a trace of the former.

X-rays and radium rays in certain dosage will produce cancer; but they also cause cell-death, even amounting to ulceration, which in its turn sets free auxetics resulting in cell-proliferation, which is prone to become malignant. Atrophy following nerve disease and injury again produces auxetic in a tissue, and these atrophic areas are liable to epithelioma, as admirably described by Lenthal Cheatle.

Much work remains to be done, therefore, before the theory regarding radio-activity can be proved to harmonise with all the facts, which must include an explanation of why it causes the death of the patient and metastasis. I do not wish to question its soundness; on the contrary, an experiment which Dr. Lazarus-Barlow has kindly made in comparing the radio-activity of the auxetic fractions of gas and blast-furnace tars appears to be evidence in its favour. Even if auxetics ultimately prove to be the sole immediate cause of cell-division, some physical force must produce the division activated by the chemical agent when it has arrived within the cell, and it is possible that this force is connected with radio-activity.

In conclusion it may be mentioned that the terms "industrial cancer," "smoker's cancer," "sweep's cancer," "arsenic cancer," etc., namely, the diseases caused by the commodities mentioned, refer in reality only to a predisposition to the disease. The commodities themselves do not actually cause cancer; they merely render the tissues prone to it, which seems to occur in a specific manner. This was clearly shown at the inquiries; the commodities always in the first instance produce cell-proliferation usually in the nature of warty growth; and it is not until an open ulcer has appeared, generally at the base of the wart, that malignancy supervenes. This fact, coupled with the knowledge that augmentors are produced in a proliferative site by the action of bacteria, makes one suspicious that the exciting cause of cancer is probably of bacterial, or, in any case, parasitic origin. The clinical evidence and the experiments that have been made into the causes of cell-proliferation and industrial cancer demonstrate that when we speak of

the cause of cancer we are dealing with two factors—(1) a predisposing cause, probably due to auxetics, which are set free by injury, X-rays, and atrophy, which are actually injected into the tissues by the commodities, and which occur in excess in the tissues generally in persons above the age of forty—the cancer age; and (2) an exciting cause, the nature of which has still to be worked out, and which supervenes on top of (1). Whatever this exciting cause is, it is responsible for the metastasis and death. It would seem that a combination of the two causes is essential, namely, that cancer is due to local manuring of the tissue; either one or other by itself appears only to cause benign tumour formation. H. C. Ross.

The John Howard McFadden Research Fund,
The Lister Institute of Preventive Medicine,
Chelsea Gardens, S.W.

DR. ROSS's letter raises the question as to whether photosensitive molecular systems of the nature of those contained in the gelatino-bromide emulsion might not be affected by auxetics and augmentors applied under suitable conditions. If such effect was found to exist, the facts he adduces would not be out of line with the view that some molecular change within the cell finds a counterpart in actions progressing in the unstable film under the stimulus of radiation or equivalent chemical influences.

The reasons set forth by Dr. Ross against the theory that soot acts mechanically appear convincing, although I cannot agree with him that this substance can be described as soft and floury. There has always been difficulty in accounting for its peculiar virulence on the mechanical theory. Some time ago I looked for the emanation of radium in soot, but found very little. If it acted like charcoal we would expect a large amount, in which case Dr. Lazarus-Barlow's views would find additional support in this direction.

I may add that some of the suggestions put forward in the lecture which was in part issued in NATURE of June 10 have been under investigation here for some time. J. JOLY.

Trinity College, Dublin.

The Magnetic Storm of June 17 and Solar Disturbances.

As my final note on Dr. Chree's letter in NATURE of July 22 and Mr. Buss's of July 29 may I remark that, so far as I am aware, there is no rule, "One spot, one storm"? On the contrary, a disturbed area of the sun's surface may be connected with a series of successive, or intermittent disturbances, as it is carried round by the sun's rotation. When the same region reappears at the next synodical rotation, and sometimes, if it survives as an active region, for several synodical rotations, it will continue to be associated with a series of magnetic disturbances at each rotation. For instance, in 1898, January 11 to July 31, a disturbed region of the sun, which subsisted during eight rotations, was associated with not one only, but with several magnetic storms, at each successive reappearance. Nor is the selection of such a region arbitrary, when there happen to be several other disturbances at the same time on the sun. The selection is conditioned by the activity of the region, and by its position relatively to the position of the earth, when projected on the sun. So far as I am aware, mere statistical enumerations of sun-spots, or total areas of sun-spots, and their relations to magnetic storms, take no account of these important considerations.

The efficiency of a disturbed region of the sun, marked by sun-spots, is greater on the descending portion of the sun-spot curve than even at maximum. The reason of this is, because after the maximum, the mean latitude of the spots is falling towards the sun's equator, and since the heliographic latitude of the earth varies between $\pm 7^\circ$, the earth is placed in a more favourable position to be affected by a solar disturbance. In the twenty-five years, 1889–1913, there were seven years in which the mean daily projected or disc-area of sun-spots was greater than 1000 10^{-6} units, and eighteen years in which it was less. In the seven maximum years there was a mean of 100 disturbances a year, and a yearly mean daily disc-area of 1537·7 units. The ratio between these two numbers, or what may be termed the "efficiency ratio," is 0·065. Similarly for the eighteen years in which the mean daily disc-area was less than 1000 10^{-6} units, the mean number of disturbances was 73·7 per year, and the yearly mean daily disc-area was 378·9 units, which gives an "efficiency ratio" 0·195, three times as great as in the maximum years. Of these eighteen years, twelve were on the descending arm of the sun-spot curve. These numbers show that the position of a disturbed region of the sun relatively to the earth is more important than its size. In addition, the character of the spot has to be considered.

To apply these principles of selection to the case of the magnetic storm of June 17. Since the beginning of 1913, all the sun-spot disturbances, with insignificant exceptions, had been confined to regions above 12° on each side of the solar equator. From June 12 to June 21 an entirely new active group of spots covering a considerable area appeared on the sun's equator. The heliographic latitude of the earth was also most favourable. The first very great magnetic storm of the present solar cycle took place on June 17, preceded by a disturbance on the 16th, and followed by a disturbance on the 18th.

With regard to the 27-day period shown in the quiet magnetic days, I associated them with the whole solar hemisphere only in this sense, that, as a rule, when there is no solar spot, there is no magnetic disturbance. The proviso is added, because a region of the sun which may be free from spots may, by the presence of faculæ or flocculi, still continue to be magnetically active, after the spots have died away. In several cases the region will continue to be magnetically active, on account of the appearance of new spots near the faculæ or flocculi belonging to the former disturbance. A. L. CORTIE.

Stonyhurst College Observatory, Blackburn,
Lancs., July 23.

Science and Food-Supply.

IN connection with the proposed "Mobilisation of Science," it may be of importance for Great Britain to direct the attention of her scientific men to the possibility of increasing the food-supply produced in the country. Here she might very hopefully call upon her organic chemists for aid; by asking them to devise means for extracting nutritive material from the crops which are not now used for food.

Nearly all vegetable matter contains the nutritive elements needed. In a certain sense, for example, "all flesh is grass"; but we cannot digest vegetable matter of that kind directly; it must be put through a chemical process before it can be assimilated. The process usually adopted is to put it into the stomachs of animals, and then we eat the animals. Through the intervention of cattle and sheep we thus eat grass in the form of beef and mutton.

In a similar manner, deer and goats and many other animals which are not limited to a grass diet convert moss, and shrubs, and bark, and small branches into nutritive material for man. The wood

of trees, too, contains the necessary elements for the support of life; but we do not utilise wood for food, because we have no animals that feed upon wood. Could not chemists do something with wood-pulp in this connection?

The German chemists are reported in the American newspapers to have succeeded in treating sawdust so as to extract a nutritive product that can be digested by man, the so-called "bread from sawdust."[1] If this is true, the British chemists should certainly be able to arrive at a similar result.

How secure Great Britain would be if she, too, could make bread from sawdust, and convert grass and shrubs and other vegetable matter not now utilised into food for her people. Here is a problem of the greatest consequence to Great Britain that should be brought to the attention of her scientific men.

ALEXANDER GRAHAM BELL.

Beinn Bhreagh, near Baddeck, Nova Scotia,
July 10.

THE PROMOTION OF RESEARCH BY THE STATE.

THE Government scheme for the organisation and development of scientific and industrial research, of which we gave particulars last week, represents a welcome concession of a principle always advocated in these columns, and stated with particular force by Sir Norman Lockyer in his presidential address on "The Influence of Brain-power on History," delivered at the Southport meeting of the British Association in 1903. The duty of a State to organise its forces as carefully for peace as for war was emphasised on that occasion; and it was urged that adequate provision for scientific education and research is an essential part of a modern State's machinery, and should be efficiently organised if we were not to fall behind other nations in the applications of science to industry. The recognition of the State's responsibility in this matter would have come much sooner if our statesmen had been wise enough to understand the scientific factors of industrial success; but it has at last been given, and the unanimous approval with which the scheme has been received must be a little surprising to the politicians who have taken so long to realise the part science is playing in the modern world, and to make provision for its national use.

There is nothing, perhaps, so difficult as to alter a long-established tradition, to effect a real change in the mental attitude of a person or of a nation. It is the greatest of revolutions; it is the real revolution on which all action out of harmony with the tradition of the past depends. Such a change of attitude, so far as the official mind of the country is concerned, was announced last May by Mr. Pease, then President of the Board of Education, when he stated in the House of Commons:

> The war has brought home to us . . . that we have been far too dependent . . . upon the foreigner, and we have realised that it is essential, if we are going to maintain our position in the world, to make better use of our scientifically trained workers, that we must increase the number of those workers, and that we must endeavour to secure that industry is closely associated with our scientific workers, and promote a proper system of encouragement of research workers, especially in our universities.

These convictions have been translated into deeds through the issue of the Government scheme. The action which has thus been taken by the Government will be hailed by all men of science with feelings of the utmost gratification. It is difficult to overestimate the value of the consequences which may follow—which, indeed, we feel sure will follow—from the adoption of this scheme. By its inception and publication the Government acknowledges and proclaims its appreciation of the work of science, and by this acknowledgment alone it gives scientific workers that encouragement and prestige in the eyes of the country which have too long been withheld.

The expenditure of any new moneys provided by Parliament for scientific and industrial research will be under the control of a committee of the Privy Council, upon the recommendation of the Advisory Council. The appointment of Lord Haldane as a non-official member of the committee of the Privy Council connects the British Science Guild with the work contemplated by the Government scheme. Lord Haldane was the first president of the guild; and at the inaugural meeting in 1905 he said:—

> I believe that things will not be right until we have a scientific corps under a permanent committee, just as the Defence Committee is under the Prime Minister to-day. I mean a body that will not consist mainly of officials of the ordinary kind, but of the most eminent men of science, who will be put on the footing upon which they deserve to be placed, and are recognised as a body of men who will be at the elbow of the department and can organise the scientific work of the State. I hope that if we get to this position the example of a Government adopting science will be followed by the municipalities, as I believe it is going to be followed more and more by our manufacturers.

The British Science Guild may justly claim some credit for securing the State assistance for industrial and scientific research now provided for by the Government scheme. For the ten years of its existence it has persistently pointed out that our competitors have brought all the products of science into the contest they have waged against us; and it has urged the adoption of similar methods in our national affairs and manufactures. Scientific men are so closely concerned with their own particular researches that they frequently take little interest in the work of others or in the position which science should occupy in national polity. Their inactivity in this respect is largely responsible for the neglect of science. A public movement was required to direct the attention of the public in general, and the Government and political parties in particular, to the value of the great resources of science in the development of the kingdom; and this movement took shape in the British Science Guild. The purpose of the guild is not so much the acquisi-

[1] For other references to what the German chemists are doing, see article on "Inorganic Fodder" in the *Scientific American* for July 3, p. 8; in which reference is also made to an attempt to derive from straw and hay all the nourishing matter contained therein.

tion of new knowledge as the appreciation of its value, and the necessity of employing scientific methods in all departments of the national executive. We regard the Government scheme as a measure of acknowledgment of the principles of State responsibility and guidance advocated by the guild; and the only regret is that action on these lines was not taken long ago, as it would have been if we had been governed by far-seeing statesmen instead of party politicians. The consequences of Government recognition will certainly be that science will secure increased attention in the thought of the nation generally, and will receive more sympathetic consideration from the industrial world.

The country, as a whole, will be influenced by the lead of the Government. "It appears incontrovertible that if we are to advance or even maintain our industrial position, we must as a nation aim at such a development of scientific and industrial research as will place us in a position to expand and strengthen our industries and to compete successfully with the most highly organised of our rivals." The attitude of mind of the British people, as a nation, towards science, and public estimation and appreciation of its value, must undergo a profound change. It is for the purpose of effecting this change and directing the resulting activity that the Government has established a permanent organisation for the promotion of industrial and scientific research.

The main channels of activity of the organisation, of which the advisory council of seven experts is the most important part, will apparently lie in three directions. First, the advisory council will act as scientific advisers to all Government departments concerned with or interested in scientific research; secondly, the advisory council, with the co-operation of the various scientific societies, will consider the application of science to industry, and will seek to enlist the interest of manufacturers; thirdly, the advisory council will advise the Board of Education as to steps which should be taken for increasing the supply of workers competent to undertake scientific research.

With regard to relations between the manufacturers and the advisory council, it is sincerely to be hoped that the former will lend their utmost assistance to the scheme, which is devised largely in their interests.

On the educational side the work of the advisory council will be of the greatest importance. As has recently been emphasised by Dr. Beilby, "our colleges have two distinct functions to perform, and it is best that this should be clearly recognised, first to allow the future leaders in applied science to come naturally to the top during their training, and secondly, to prepare a large number of well-trained professional men for the organisation and development of industry." How best to secure these two classes of men in adequate numbers, and, more important perhaps, how to induce an adequate number of the right kind of men to enter the chemical profession, will require careful consideration on the part of the advisory council. It may, however, be hoped that the council will not pin its faith too much to bursaries and scholarships, but will rather seek to create inducements in the shape of posts which are adequately remunerated, more highly remunerated certainly than has been the case in the past.

MODERN PROCESSES OF MANUFACTURING HYDROGEN FOR AIRSHIPS.

IN the *Revue Générale des Sciences* for June 15, M. A. Fournois reviews the earlier methods for the preparation of hydrogen for balloons, and describes in some detail the more modern processes for its manufacture, especially those adapted to field use. The large amount required in the present campaigns can be conjectured from the capacity of the latest type of Zeppelin, which is stated to be some 30,000 cubic metres.

Many of the earlier processes now possess little beyond theoretical interest. The well-known zinc-sulphuric acid reaction always presented difficulties in the transport of materials, of which large amounts were required. The dangers attendant to the transport of the acid were largely overcome by absorption with acid sodium sulphate, the solid material being dissolved as required, but some 15 kilos. of the mixture were necessary for the preparation of one cubic metre of the gas.

The electrolytic production was a great advance, although the process was naturally expensive, and only possible at fixed generating stations. When the preparation of chlorine by the electrolysis of salt solutions was developed, hydrogen, being a by-product, was available at a cheaper rate. Such gas must always be supplied compressed in the usual gas cylinders, and here again transport difficulties arose, to say nothing of the dangers inherent to the transport of gas at 150 kilos. pressure into the field. One of the ordinary waggons will carry only some 13 kilos. of hydrogen—a small proportion of the total weight of the load—and this is roughly only one-hundredth of the gas required for an ordinary dirigible.

Naturally therefore great attention has been directed during the last few years to methods of preparation suitable for field use. The most successful of these have been the action of water on calcium hydride (CaH_2) (hydrolite), and the action of caustic soda on ferrosilicon or silicon itself.

Hydrolite is an expensive material—about five francs per kilo.—but the total cost of the outfit for 50,000 cubic metres is given as only about one-third of the cost of the gas in cylinders, one vehicle sufficing for the transport of the hydrolite plant, as against twelve required for gas cylinders. A vehicle carrying six generators gives an output of 500 cubic metres per hour.

In the ferrosilicon process the fine material falls into caustic soda, which is covered with a layer of hydrocarbon oil to prevent frothing. A base plant has an output of 1500 cubic metres per hour; a field plant, comprising two waggons, 400 cubic metres.

Hydrogenite—a mixture of ferrosilicon with dry caustic soda, which only requires addition of water for generation of the gas—has been used in the French service. One cubic metre of the gas is produced from 3 kilos. of the hydrogenite. The German Schuckert process employs silicon alone, an expensive material, and one which requires external heating of the generators.

Two other most interesting processes for the preparation of gas for balloons are mentioned. The decomposition of acetylene in strong steel cylinders by electric sparks is of particular interest by reason of the gas prepared in this way having been used at the Zeppelin factory at Friedrichshaven. The process gave rise to a serious explosion in 1910. The finely divided carbon deposited in the decomposition cylinders is used for the manufacture of printers' ink.

Another process, of Dutch origin, that of Rincker and Wolter, has also been used in Germany. Generators filled with metallurgical coke are blown to incandescence, the air blast shut off, and suitable oils injected until the fall of temperature necessitates a further air blast. In a portable plant described in a recent issue of the *Scientific American*, one waggon carries two generators, with oil tanks, blower, &c.; a second car carries the purifiers. The gas passes through the generators in series, and purification is effected by sulphuric acid scrubbing, and finally by caustic soda to remove carbon dioxide. With highly incandescent coke the gas is stated to be nearly as light as hydrogen; it has some illuminating value, and is also stated to be suitable for use as an auxiliary gas for furnace work.

SCIENCE, MUSEUMS, AND THE PRESS.

TECHNICAL workers in science and in allied fields are accustomed to say that the general Press either pays no attention at all to subjects which they themselves believe to have a very important bearing upon the welfare of the people, and to be if properly treated of great public interest, or that it seizes upon only some isolated facts which are capable of being treated in a sensational way so as to furnish "good copy," but with the result of conveying an erroneous and often harmful impression. It is, we are constantly assured, the fact that newspaper editors really would like to have good and accurate popular articles on various branches of science, both pure and applied. The difficulty in obtaining them is twofold. First, that the ordinary journalist, untrained in special subjects, cannot be expected to see the really essential points or to present them in an accurate manner. Secondly, that the scientific worker generally has far too heavy a touch to appeal to the public. An attempt is sometimes made to bring the journalist and the man of science into co-operation by means of an interview, but in this country, at any rate, the scientific worker is apt to dread personal advertisement, and on the other hand he may not altogether care about giving news or opinions of pecuniary value for another person to take the reward. At any rate the interview generally results in the man of science being made to utter some notable absurdities.

There is, however, another intermediary through which the technical worker can approach a wider public, and that is afforded by the public galleries of our museums, which are coming more and more to rank as educational establishments of prime importance, catering not only for advanced students, but also for school children, and for many who might object to any title so serious as that of students. In so far as the exhibited series of our museums are intended to appeal to this wider and less educated public, they must do so by means of striking objects, attractive installations, and specially prepared labels. To these may be added: printed guides, which are purchased by a very small percentage of the visitors, and in any case are not as a rule written in a style alluring to those who seek amusement rather than instruction; human guides, who may take a perhaps larger but still a small percentage of the visitors round the galleries; and lastly, lectures with the added attraction of lantern-slides, dealing with special portions of the collections.

Many museums, both in Europe and America, are working hard along these lines, and have effected a considerable increase in the number of their visitors. But when all is said and done the proportion of visitors to the number of the surrounding population is indeed a small one. Some American museums claim a proportion as high as 35 per cent., but this, it must be remembered, refers to the number of visits, not to the number of visitors, which is certainly considerably less. Now it is absurd to spend money, time, and trouble in producing an attractive exhibition and then to leave members of the public to find out the fact for themselves. The museums must not be above taking the same steps as are taken by all other caterers for public amusement and instruction. In some form or other the museum must advertise. Here, then, may possibly be found a solution of the difficulty with which we started. Let the museum frankly admit that it must advertise, and let it take the Press for what it is, as the best advertising agent. The Press, on the other hand, welcomes good copy, and in return for that will not in the least mind directing attention to a public non-commercial institution. To accomplish this, the museum should have under the control of the director, a Press department, composed of the best writers on the staff, each of whom should be instructed as part of his official duties to draw up striking articles, not falsely sensational, but none the less abounding in "crispness," "snap," and "go."

Some such course as that just advocated is now being taken by the Smithsonian Institution, which for the past year or two has distributed to the general and scientific Press free articles written in lucid, popular fashion, dealing with all kinds of matters of novel interest in the United States' National Museum, and with other branches of the

Institution's work. Among the subjects of those which have lately been sent to us may be mentioned: "Orchids," "Stegosaurus," "Whetstones," "American History," "Fashions," "Gerenuk Gazelle," "Printing for the Blind," "Relics of the Grinnell Expedition," "Spectroscopic Determination of Minerals," "Gypsum," and "Printing Ink." Some of these deal with publications, others with accessions to the collection or with special exhibitions. Newspaper editors are at liberty to make what use they please of these articles, condensing or embroidering at their fancy. But the result, it is doubtless hoped, is that readers of the newspapers will either send for the publications referred to or visit the exhibition. The Press statements are distributed a few days before it is intended that they shall appear, and editors are requested to return a card of acknowledgment that they have been so used. We shall probably learn the result of the experiment in some future report of the Smithsonian Institution, to which museum curators in this country will look forward with much interest. Although some of our museums, both national and provincial, already utilise the Press in this direct official manner, we are under the impression that their communications are neither so frequent nor so freely distributed as those of the United States National Museum appear to be; neither are they written with quite the same obvious intention of furnishing easy reading for the average citizen.

EXPLORATION IN THE KARAKORUM.

DR. FILIPPO DI FILIPPI'S paper to the Royal Geographical Society on June 14 is the record of an expedition more thoroughly equipped, from a purely scientific point of view, than any that has yet attacked the many problems still awaiting solution in the dreary solitudes that lie beyond the valley of the upper Indus. To one who knows by experience the labour involved in transferring himself for a few months only, with no more elaborate outfit than a single tent, a geological hammer, and a camera, to the higher regions of the Himalaya, it seems almost incredible that such items should be included in the impedimenta as a complete wireless installation; pilot balloons, with the hydrogen for their inflation carried in sixteen steel cylinders; and other scientific gear; to say nothing of tents for a party numbering one hundred and fifty persons, and the provisions, amounting to some forty-six tons, requisite for a sojourn of many months in that most inhospitable country. Yet the task was brought to a successful conclusion, in the face of every obstacle that Nature in her most inclement mood could oppose to it. We are left to imagine with how great an expenditure of patience and energy, for the modest narrative of the leader of the expedition, Signor Filippo di Filippi, makes light of this aspect of the achievement.

The programme was certainly ambitious. It included a topographical survey of the Karakoram east of the Siachen glacier, where the great Remo glacier was found to possess some of the features of an ice-cap, its upper basin being described as a vast circus filled to the brim with ice, which overflows between the surrounding peaks, while one of its branches sends its waters down the Yarkand river into Central Asia, and another feeds the Shyok, a tributary of the Indus: a series of gravimetric observations designed to connect the work of the survey of India along the southern flanks of the Himalaya with that of the Russians in Turkestan: determinations of longitude by means of wireless time signals transmitted from Lahore: a comprehensive study of the geology, not confined to the main route traversed by the expedition, combined with a collection of anthropological data: and lastly, astronomical and meteorological observations, with complete photographic and cinematographic records.

Leaving Skardu, where it had passed the winter, in February, 1914, the expedition, making its way over passes deep in snow, arrived in the beginning of June on the Depsang plateau, a desolate expanse of minute detritus, at an altitude of 17,400 ft. above the sea, "entirely devoid of vegetation except for occasional patches of a yellowish-green plant which at first view suggests, more than anything else, some malignant disease of the soil." On this plateau, constantly swept by an icy wind, and deluged with storms of hail and sleet, the scientific work of the expedition was carried on until late in August, when the journey to the plains of Russian Turkestan was resumed and successfully accomplished early in November.

The scientific results of this expedition will be awaited with eager interest. They cannot fail to throw light upon the geodetic aspects of the Himalayan problem, which have recently been the subject of much discussion, and on meteorological questions of great moment in India. It will be interesting also to compare the geological results with the observations of Stoliczka, who traversed the same route more than forty years ago, and whose classification of the formations met with in the N.W. Himalaya remains practically unimpaired to the present day.

T. H. D. L.

NOTES.

THE Moxon gold medal of the Royal College of Physicians has been awarded to Prof. J. J. Déjerine, of Paris, and the Baly gold medal to Dr. F. Gowland Hopkins.

WE learn from *Science* that the Board of Estimate and Apportionment of New York City has passed a resolution authorising the issue of 20,000*l.* corporate stock of the City of New York to provide means for permanent improvements at the Brooklyn Botanic Garden, including the completion of the laboratory building and plant houses. This action was taken following the generous offer of Mr. A. T. White, chairman of the Botanic Garden Committee of the Brooklyn Institute trustees, to secure a like sum by private subscription. The amount was subscribed by

Mr. White and the donors of the original endowment of the garden. Plans are now being prepared for the completion of the buildings, only one-fifth of which has been erected.

THE death is announced on July 23 of Dr. Edmund Owen, consulting surgeon to St. Mary's and other hospitals. He was also surgeon-in-chief to the St. John Ambulance Brigade. Dr. Owen was in 1867 appointed demonstrator and in 1876 lecturer in anatomy at St. Mary's Hospital Medical School. In addition to numerous more technical works, he published in 1890 a "Manual of Anatomy for Senior Students." The article on "Surgery" in the current edition of the "Encyclopædia Britannica" was from his pen. He was a member of the council of the Royal College of Surgeons for sixteen years, and a vice-president of the college. He became a member of the British Medical Association early in his career, and in 1883 he was secretary of the Section of Surgery at the Liverpool meeting, from which date he took an increasingly important part in its affairs. In 1906 he delivered the Bradshaw lecture on cancer, and in 1911 the Hunterian oration.

THE following additional lists have reached us of members of scientific staffs on active service with H.M. Forces:—DUBLIN: *Geological Survey of Ireland*:—T. Haigh, professional assistant (chemist and soil analyst), Sergt. 7th Batt. Royal Dublin Fusiliers; H. T. Kennedy, geologist, Lieut. Royal Scots Fusiliers; R. L. Valentine, geologist, Lieut. 8th Batt. Royal Dublin Fusiliers. LONDON: *Geological Survey*:—C. H. Cunnington, geologist, 2nd Lieut.; R. J. A. Eckford, fossil collector, Lance-Corpl.; R. du B. Evans, geologist, 2nd Lieut. (wounded and prisoner); P. A. Frisby, assistant clerk, Sergt.; D. Haldane, fossil collector, Sergt.; W. B. R. King, geologist, Lieut.; R. W. Pocock, geologist, 2nd Lieut.; H. H. Read, geologist, private; J. E. Richey, geologist, 2nd Lieut.; A. P. Stewart, general assistant, private; T. H. Whitehead, geologist, Lieut.—Dr. E. N. da C. Andrade, who held a John Harling fellowship in the University of Manchester at the outbreak of war, and was engaged in physical researches, though not on the teaching staff, is a 2nd Lieut. in the Royal Garrison Artillery.

IN response to the circular letter referring to offers of service connected with the war, sent to fellows of the Chemical Society on July 1 (see NATURE, July 8, p. 523) more than 900 forms have been received, together with many letters and suggestions. In that letter it was stated that in dealing with these replies the council would have the assistance of special committees, each of which would be formed by a kindred society. The following societies are co-operating:—Royal Agricultural Society, Biochemical Society, Society of Chemical Industry, Society of Dyers and Colourists, Faraday Society, Institute of Chemistry, Institute of Metals, Institution of Mining and Metallurgy, Pharmaceutical Society, Physical Society, Society of Public Analysts. Each of these societies will nominate six experts who, together with two members of the council of the Chemical Society, will form a committee to consider and report on matters referred to it by the council. In addition to these special committees, a general committee is in course of formation which will consist of about twenty members, two being nominated by each of the co-operating societies. The function of this general committee will be to deliberate on all questions of general policy with reference, not merely to questions directly relating to the war, but also to all matters on which it is desirable to have the opinion of a body thoroughly representative of every department of chemical science.

IN the course of a statement on the work of the Ministry of Munitions, made in the House of Commons on July 28, Mr. Lloyd George said:—"I have just completed arrangements to constitute an Inventions Branch of the Ministry of Munitions, and I hope it will do for inventions for land warfare what Lord Fisher's Board is doing for naval warfare. The War Office is handing over the whole question of Army inventions to the Minister of Munitions, and careful arrangements are being made to secure that the new branch will keep in close touch both with Lord Fisher's to avoid duplication and overlapping, and also with War Office experts and Army authorities, who must, of course, have an ultimate voice in deciding whether a particular invention is of practical service to the conditions of actual warfare in the present campaign. I have appointed Mr. C. W. Moir, a distinguished engineer, who has already given valuable assistance to my Department on a voluntary basis, to take charge of the new branch, and he will not only have an expert staff to deal with any project that may reach him, but also a panel of scientific consultants to assist on technical and scientific points. I think to save disappointment I ought to say that it ought to be clearly understood that only a very small minority of inventions are of practical value, especially under the stringent conditions of modern warfare. Many projects fail from technical defects, many others, although technically perfect, are unsuitable for the practical conditions of war. The new branch will have justified its existence if one project in a hundred, or even one in a thousand, turns out to be of practical utility in the present emergency."

SCIENCE in Oxford has suffered a further loss by the death of Dr. A. J. Herbertson, of Wadham College, professor of and reader in geography. A native of Scotland, Prof. Herbertson prepared himself for his scientific career by a course of study in Germany, where he graduated as Ph.D. of the University of Freiburg. Appointed reader at Oxford in 1905 and professor in 1910, he was enabled by the liberality of the Royal Geographical Society, and with the support of the University, to establish and equip a department representing not unworthily a branch of natural knowledge which it must be confessed had up to ten years ago received scant recognition in Oxford. It is not too much to say that to the zeal and energy of the late professor is mainly due the flourishing condition of the school of geography now housed in the well-known building which was for so long the abode of the late Sir Henry Acland. He spared no effort in

urging upon the University the importance of his subject, whether from the scientific or the historical point of view. He secured the services of able colleagues, and by his own powers of organisation and the unceasing labour which he brought to bear upon his work, he succeeded in vindicating for geography something like its proper place in the studies of the University. Prof. Herbertson had done good service as a member of the Royal Commission on Canals and Waterways, and in 1910 he was president of the Section of Geography of the British Association. His numerous publications are well known to all geographers, two of particular scientific importance being an "Atlas of Meteorology" (with Mr. J. G. Bartholomew) and "The Distribution of Rainfall over the Land." His death took place on July 31, at fifty years of age, after a somewhat protracted period of ill-health.

UNDER the title of "War, Wounds, and Disease," Sir William Osler has published a very useful little article in the July number of the *Quarterly Review*. He takes for his text a dismal old saying, that "Disease, not battle, digs the soldier's grave." It dug that grave deep for the Walcheren Expedition: 23,000 deaths from disease, against 217 killed in action. Again, in the Russo-Turkish war of 1829, there were 40,000 Russians in the hospitals. Sir William Osler reproduces here a very notable diagram, from an article by Kozlovski, showing the losses from disease, and the losses of killed and wounded, in the Crimean and other wars. We are often told that the Japanese, in the Russo-Japanese war, were notably free from disease; but it appears, from Capt. Culmann's paper in the Journal of the R.A.M.C., vol. xiii., that they had no fewer than 51·4 of their strength on the sick list. In the present war, we are justly proud and thankful that the incidence of disease has been light, thanks to the splendid work of the Army Medical Department and the Army Transport Service. Sir William Osler directs attention to the very large proportion of our wounded who are able to return to their arduous duty; it is no fewer than 60 per cent. Then, after noting the unhappy frequency of illnesses from exposure—pneumonia, bronchitis, rheumatism—he reviews the diseases of infection, most of which, in other wars, have been so terrible: wound-infection, tetanus, gas-gangrene, typhus, cerebro-spinal fever, typhoid, cholera, and venereal disease; and to these he adds a note on cases of over-strained and overborne "nerves." Happily, he is able to give a very good report of the general health of the Army; but he warns us that the danger is not yet past. "On the whole, the country may be congratulated on the comparatively small part disease has so far played in the great war. There has been no epidemic on a large scale; and with effective measures it may be hoped that we shall escape the terrible experiences of South Africa and the Crimea."

THE United States Government in the Philippine Islands has displayed laudable zeal in collecting information on the ethnography of the native races. In 1911 the Governor-General directed that each provincial governor should call together the old men of each tribe and collect all available information about the community in his charge. In reply to this circular about 600 reports of varying interest and value have been received. As a first instalment, Mr. J. A. Robertson, librarian, Philippine Library, Manila, has compiled a monograph on the Igorots of Lepanto, published in the *Philippine Journal of Science* for November, 1914, giving a number of interesting facts on the social life, manners and customs, magic and religion of this tribe. The report is provided with a bibliography and some useful photographs, and may be recommended to ethnologists.

THE *Pioneer Mail* of June 18 reports an interesting lecture delivered at Simla by Capt. Acton, health officer, on snakes and snake-charmers. Many snake-charmers pretend that they owe their immunity to graduated doses of venom, but examination of several individuals failed to verify this statement. The snake-charmer at the Calcutta Zoological Gardens rubs venom into any cut he receives, but he uses permanganate and anti-venene whenever he is bitten. Unless graduated injections could be carried on for a year, or at least six months, they would not be sufficient to resist the huge dose of venom from a cobra's bite. Many of them often carry about the non-poisonous John's earth snake, which is shown to the credulous as double-headed. As a matter of fact, immunity is secured by careful handling of the reptiles, the charmers being taught the art from early youth. Their remedies fall into three classes: snake-stones; drugs and herbs like arsenic, antimony, arislotochia, and opium; invocations and magical formulæ. "It is," he observed, "a well-recognised principle in medical science that any disease which has a host of reputed cures means only one thing—that there is no cure, and that the disease has a small death-rate. About 90 per cent. of the cases survive whatever remedy is employed, and this large percentage gives sufficient excuse for reputed cures."

SOME interesting notes on the habits of the four-horned spider-crab (*Pisa tetraodon*) appear in the *Zoologist* for July, by Mr. H. N. Milligan. The author's observations were made upon captive specimens in the aquaria in the Horniman Museum, where this species appears to thrive. The facts recorded refer mainly to the behaviour under the stimulus of fear, the manner of attaching seaweed and other foreign bodies to the shell, and the apparently abnormal relish which the females exhibit for their own eggs, which are devoured almost as soon as laid. Since these are of a bright vermilion colour, and very conspicuous, they would seem to be warningly coloured in so far as other egg-eating animals are concerned. Whether *Pisa tetraodon* habitually devours its own eggs when at large there is at present no means of discovering.

TWO admirable essays, the one on the "Home Life of the Kestrel," by Mr. Oswald Wilkinson, the other on "Hobbies in the Vale of White Horse," by the Rev. J. G. Cornish, appear in *Wild Life* for July. In each case a most careful study of the nesting habits and care of the young is given, and these notes are supplemented by a series of very beautiful photographs.

Mr. Wilkinson speaks of wood-pigeons as forming a common article in the dietary of the kestrel. From the great size and weight of this bird, in relation to the kestrel, one cannot resist a suspicion that he is really referring to the turtle-dove. The wanton destruction, both of the kestrel and the hobby, by gamekeepers, gives one cause for rejoicing that at least occasionally they escape the varied and often brutal engines of destruction which, in spite of Preservation Acts, are still in common use. This persecution is the more reprehensible because these birds, like owls, destroy immense numbers of mice and rats, whereas the amount of game destroyed is negligible, as anyone can discover for himself who will take the trouble to examine the pellets thrown up according to the custom of raptorial birds. Not one pellet in ten thousand will be found to contain remains of partridge or pheasant.

THE annual report of the Scottish Marine Biological Association for 1914 contains a record of the work done at the Millport Marine Station during that year. The most important investigations to which reference is made in the superintendent's report are those of Dr. J. F. Gemmill on the development of *Asterias rubens*, the detailed paper on which has appeared in the Philosophical Transactions of the Royal Society. Other work of interest is the systematic investigation of a sandy shore undertaken by Mr. R. Elmhirst and Prof. L. A. L. King, and the study of the regeneration of legs in Crustacean Decapods by Mr. J. H. Paul.

TWO papers by Dr. C. G. Joh. Petersen make up the Report of the Danish Biological Station, No. xxiii, 1915. The first is on the animal communities of the sea-bottom in the Skagerak, the Christiania fjord, and the Danish waters, and is a continuation of similar studies already published by the author dealing with the communities found in Danish waters. The investigations were made by means of the bottom-sampler designed by Dr. Petersen. The second paper is called, "A Preliminary Result of the Investigations on the Valuation of the Sea," and in it an attempt is made to give numerical estimates of the annual production of various marine organisms, including fishes, in the Kattegat. Whilst undue importance is not intended to be given to the actual figures put forward, the method followed by Dr. Petersen is one which will doubtless be capable of great development in the future.

THE July number of the *Quarterly Review* contains an article by Mr. Stephen Reynolds dealing in a general way with the question of the inshore fisheries, but referring specially to the two Departmental Reports published in 1914. The author traces the various causes which have led to the decadence of sea-fishing by small boats on various parts of the coasts of England and Wales. In his opinion the decentralisation of administration brought about by the creation of the District Fishery Committees has had a prejudicial effect. These bodies are not really representative of the fishing interests; and they are, with one or two exceptions, unprovided with sufficient resources to enable them to carry on constructive work, scientific research, or the legal defence of existing fishing rights. Their work has been mainly that of the imposition of restrictions and prohibitions on methods of fishing. The committees are subject to the general control of the central authority (the Board of Agriculture and Fisheries), but the latter possesses no power to initiate legislation. The Inshore Fisheries Committee, which reported in 1914, recommended the practical abolition of the District Committees and the transfer of the actual power of regulation to the central authority. It also recommended various schemes of local organisation and co-operation, and with the assistance of the Development Fund some of these have been begun. Mr. Reynolds describes very shortly the steps that are being taken in Devon and Cornwall to revive and stimulate the smaller fisheries, mainly by means of loans of money to the men. A grant from the Development Fund has also been made to the Fisheries Organisation Society, so that this body has been able to provide a staff for the promotion of the industry.

IN the July number of the *Journal of Anatomy and Physiology* Prof. F. Wood Jones makes a welcome contribution to our knowledge of the external genital system of Chelonian reptiles. He regards the external genitalia of turtles and tortoises as representative of a very generalised and primitive type. The commencement of the Chelonian type of copulatory organ is to be seen amongst certain of the Amphibia; the same type occurs as an embryological stage in mammals. The author regards it as probable that "the mammalian stock arose early from some basal meeting point of the Amphibians and the sculate reptiles."

IN 1913 Sir Edward Schäfer accepted an invitation from the Leland Stanford Junior University, California, to deliver the Laue medical lectures. He chose for his subject the endocrine glands—that is, the organs of the body which form internal secretions. His name is so closely associated with researches on these glands, especially the adrenal and pituitary bodies, that his choice was an almost obvious one, and those who did not have the opportunity of hearing Sir Edward are now able to read his lectures, as they have been published by the Stanford University in a pamphlet of ninety-four pages, which is simply packed with information expressed in lucid style, and admirably arranged. We can highly recommend the booklet to those who wish to obtain a brief history of our knowledge on this interesting subject, and an authoritative statement of the stage it has reached at present. We note that the author employs his new nomenclature for the substances usually grouped together as hormones; so far the new words have not "caught on," but perhaps the present publication will stimulate other physiologists to adopt them. The same mail brings us another publication in the same series, "The Hæmolymph Nodes of the Sheep," by A. W. Meyer, from the anatomical department of the Stanford University. The subject is not altogether unrelated to the endocrine glands, though it is at present doubtful whether these nodes, or accessory spleens, as they may roughly be termed, form any internal secretion. Dr. Meyer, however, treats the subject mainly from the anatomical point of view, and

his paper is illustrated with some very beautiful drawings.

AN interesting contribution to our knowledge of abnormalities in the reproduction of vertebrates has been made by Mr. R. Curtis in a paper on the relation of simultaneous ovulation to the production of double-yolked eggs in the domestic fowl (*Journ. Agric. Research*, vol. iii., No. 5). Such eggs may have (1) the entire set of egg-envelopes common to the two yolks, or (2) the chalaziferous layers separate and the thick albumen common, or (3) entirely separate albumen envelopes and only the membrane and shell common. Of the eggs examined, 71 per cent. belonged to the second type. In only very few cases was there evidence of simultaneous ovulation, and the author believes that "the fusion of follicles and a resulting common blood-supply is by no means the usual cause for the production of a double-yolked egg." In the Report of the Maine Agric. Exp. Station for 1915 (pp. 65–80) Dr. R. Pearl and Mr. F. M. Surface describe a cow which assumed some of the secondary characters of the male, developing thickness of neck and smoothness of rump, and also behaving in many respects like a bull. This animal had been, before the strange change, a normal cow, having borne three calves and shown a high milk record. Post-mortem study showed cystic degeneration of the ovaries in which no corpora lutea were being formed. Hence the authors conclude that the corpus luteum is of importance in maintaining female secondary characters in full development.

WE have received a copy of a paper on the fungus diseases of *Hevea brasiliensis* contributed by Mr. T. Petch, Government mycologist, Ceylon, to the International Rubber Congress held at Batavia yast year. It is reassuring to read that notwithstanding the vast areas under Hevea cultivation, often under bad conditions, no very serious parasitic fungus has as yet been noticed. *Fomes semitosus*, the root disease, first recorded by Ridley at Singapore in 1904, which was much feared, is proving to be of minor importance as the plantations increase in age and as the jungle stumps on which it flourishes disappear. The stem diseases, of which six have been recorded, are perhaps the most dangerous. Three of these, pink disease (*Corticum salmonicolor*), die-back (caused especially by *Botryodiplodia theobromae*), a well-known cacao disease, and canker due to *Phytophthora faberi*, are especially to be feared. It is suggested that Bordeaux mixture may prove effective as a preventive to canker.

THE annual report of the agricultural and horticultural research station of the University of Bristol, otherwise known as the National Fruit and Cider Institute, at Long Ashton, contains a series of papers on cider and perry, mainly by Prof. B. T. B. Barker and Mr. Otto Grove; papers on the treatment of plant disease, by Mr. A. H. Lees; on economic mycology, by Mr. S. P. Wiltshire; on fruit culture trials, by Prof. Barker; and on soils and manures, by Mr. C. T. Gimingham. Among these papers one on the use of pure yeast in the fermentation of cider by Mr. Grove, and a note by Mr. Gimingham on the use of the waste from saw-mills as a source of potash have a general interest. The fact that the ash or flue-dust from saw-mills which burn wood as fuel contains from 5 to 9 per cent. of potash, is not generally realised, and no attempt has been made hitherto to store or utilise this material, which certainly has a manurial value, especially at the present time. In September last the Board of Agriculture and Fisheries organised a series of experiments on the preservation of fruit and vegetables by drying, canning, and other methods, and preliminary experiments were made by Dr. Hamilton at Studley College, and by Mr. C. S. Martin at Dunnington Heath. This work has now been developed, and two experimental factories are being carried on at Dunnington Heath and Broom Junction.

A CATALOGUE of earthquakes felt in the Philippine Islands during 1914 has been issued by the U.S. Weather Bureau. The year was apparently uneventful, the total number of shocks recorded in the islands being 146. None of the earthquakes was of destructive strength, and only twenty-nine were of intensity above the fourth degree of the Rossi-Forel scale. As in all distinctly seismic countries, many of the disturbed areas were extremely elongated in form. The Philippine earthquakes are, however, peculiar in possessing large disturbed areas. For instance, the average area disturbed by earthquakes of intensity 4 is 9660 square miles. In Great Britain, the corresponding figure is 260 square miles.

THE refined methods of modern seismology are well exemplified in a paper by Prince Galitzin, presented to the Paris Academy of Sciences on June 21 (*Comptes rendus*, vol. clx., p. 810), dealing with the earthquake widely recorded on February 18, 1911. This disturbance has been prevented from falling into oblivion by the fact that the survey work of a Russian officer has brought to light the simultaneous occurrence of a cataclysmic land slide at Sarez, a situation well within the area of the epicentre as determined from the records obtained at Tashkent, Tiflis, and Pulkowa. It is easy to calculate the energy (E) liberated in this catastrophe from estimates of the weight of the disrupted mountain and the average vertical fall, whence in c.g.s. units $E=2{\cdot}1$ to $6{\cdot}0\times10^{23}$ ergs. Prince Galitzin next determines the energy by means of the Pulkowa seismographic records, and obtains finally $E=4{\cdot}3\times10^{23}$ ergs. The two values are of precisely the same order of magnitude; hence the conclusion is drawn that the landslip at Sarez was the cause, and not the effect, of the earthquake of February 18, 1911, which thus presents a unique case where the energy liberated at the epicentre, here identical with hypocentre, is known.

THE Department of Agriculture and Technical Instruction for Ireland has reissued the explanatory memoir of the Geological Survey of Ireland, illustrating parts of the counties of Armagh, Fermanagh, and Monaghan (H.M. Stationery Office, Dublin, 1914; pp. i–iv+26; coloured map; price 3½*d.*). The memoir describes the country around the town of Monaghan, one-inch map sheet 58. The issue of a larger and cheaper edition has provided an opportunity to add a chapter on the relation of the soils to agriculture in the district, and to describe the drumlins,

here so well developed. The provision of a small-scale coloured map of the "solid" geology marks an important advance on the earlier edition. Plate ii., which should face p. 16, is absent from the copy we have examined.

THE report of the Fernley Observatory at Southport for the year 1914, prepared by Mr. Joseph Baxendell, meteorologist to the Southport Corporation, gives results of considerable interest. The observations have been systematically continued for the last forty-three years, and the values give a good average for intercomparison. A table is given showing the diurnal variation of the winds from different directions for the whole year, based on the observations of fifteen years to 1913, and a diagram shows the summer wind-direction frequencies for the same period. The great prevalence in summer of sea winds, from west and north-west, is well indicated, and there is a much greater prevalence of these winds in the day than in the night. Detailed tables of the several meteorological elements are given for 1914. The warmest month was August, with a mean temperature of 60·6°, which, however, is only 0·7° warmer than July, while the coldest month is January, with the mean temperature 39·9°. The temperature during the year ranged from 80° to 22°. The rainfall for the year was 32·02 in., and the wettest months were July and December, the percentage of the average being respectively 159 and 165. The brightest month was June, with 234 hours' sunshine, whilst April and August were very nearly as bright.

VOL. XXXV., part i., 1913, of the Annals of the Royal Central Office of Meteorology and Geodynamics of Rome contains a long memoir by Prof. Palazzo describing magnetic observations which he took during June, July, and August of 1913 in the Italian colony of Eritrea bordering on the Red Sea. The principal instruments employed were a magnetometer and dip circle by Dover. Observations were taken at sixteen stations situated between 14° 47′ N. and 15° 47′ N. One of the stations was on an island in the Red Sea, the others on the mainland, mostly at considerable heights, in one case 2410 metres above sea-level. The results are summarised on p. 75. A chart at the end shows the stations, and includes isogonals for 1° 30′ to 1° 50′ W., isoclinals from 11° 0′ to 13° 0′ N., and lines of equal horizontal intensity. The isoclinals are nearly parallels of latitude. On p. 89 there is a record of results by other observers in Eritrea. At Massaua (Massowah), on the Red Sea, there were in all results from eight observers, including Prof. Palazzo, the earliest going back to 1839. Conclusions are drawn from these as to the secular change. A summary of the results also appears in a short paper by Prof. Palazzo in the *Rendiconti Accademia dei Lincei*, January, 1915.

THE July number of the *Journal* of the Röntgen Society contains the paper which Mr. F. Harrison Glew read before the Society in April, describing a new mechanical effect of the α rays from radio-active bodies. Mr. Glew finds that if a very thin strip of mica has one side exposed to α rays for a week or two the strip is bent, the side exposed to the rays becoming convex and displaying iridescent colours. In one experiment a strip 2 mm. by 11 mm. and 0·01 mm. thick was exposed for a month to the α rays coming from a mica-covered capsule containing two milligrams of mesothorium. The strip was supported at one end so as to be 3 mm. above the cover of the capsule. It was found to have acquired a curvature equal to that of a circle of radius 48 mm. and required a weight of 460 milligrams applied to its middle point to straighten it. When reading his paper Mr. Glew suggested that the α particles arrested by the mica existed as occluded helium in the strip, an opinion which has since been verified by Mr. J. H. Gardiner, who on heating a strip *in vacuo* obtained the helium spectrum.

THE U.S. Department of Commerce has published a second edition of Circular No. 20 of the Bureau of Standards. The circular presents briefly, in its first section, the principles underlying the construction and operation of commercial electrical measuring instruments. This is followed by a particularly useful section on the performance of such instruments; the subjects discussed include accuracy, sensitivity, reliability, the effects of temperature change, temperature-coefficients, the effects of stray magnetic and electrostatic fields, the effects of imperfect elasticity of springs and of friction, and the construction of scales. The information on the temperature-coefficients of voltmeters and ammeters is very useful, and methods are suggested for compensating for ordinary temperature changes. The last section contains valuable hints on the testing of instruments; it discusses in detail the application of the potentiometer to the measurement of voltage and current. Owing to its smaller temperature-coefficient, the Weston portable cell of the unsaturated type is recommended as being preferable to the Weston normal cell, in which saturated solution is used. The circular may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C.

THE valuable reports and other publications issued by the British Fire Prevention Committee have frequently been referred to in these columns. The war emergency work accomplished by the committee during the past twelve months has been of a very extensive character, and is a remarkable example of what can be done entirely gratuitously by voluntary workers. The following are special features of the work dealt with by the committee during the first year of the war:—*Fire Survey Force*: At the outbreak of war, the committee formed a special Fire Survey Force of 100 surveyors to undertake at short notice any fire surveys required by the Government in an honorary capacity. Above 900 establishments taken over for war emergency work all over the country were surveyed by this force, with a total of more than 40,000 beds. Latterly re-surveys are made in cases of special fire risk. *Fire Warnings*: The warning service embraced the preparation and free issue of a large number of public "fire warnings" in connection with the war emergency, disseminated by the committee in the form of posters, circular letters, or as notices reproduced by the Press, etc. The total issue of posters and like publications exceeds 200,000. *Fire*

Service Force: The Special Fire Service Force, organised by the committee at the outbreak of the war, and comprising ex-fire brigade officers and firemen, was originally brought into such a form as to make 300 firemen readily available for mobilisation in sections within forty-eight hours. The results of the work of the committee have been far-reaching. The great care taken by the public on simple, sensible, and inexpensive lines to prevent outbreaks of fires and to meet them with organised self-help is extraordinary, and must affect the reduction of the fire loss after the war, as it has during the war.

A COPY of the thirteenth half-yearly volume of the Journal of the Institute of Metals has been received. For the most part the volume is a record of the papers read at the recent London meeting of the institute, to many of which attention has been directed already in these columns. In addition, there is an important contribution on "Bronzing Processes Suitable for Brass and Copper," by Mr. T. J. Baker, read on January 26 last at the Birmingham section of the institute. The part of the book containing abstracts of foreign scientific papers dealing with copper, brass, and other non-ferrous metals is remarkably complete in view of the difficulty of obtaining access to Continental periodicals. The volume contains 471 pages, ten full-page plates, and numerous illustrations in the text. It is issued under the editorship of Mr. G. Shaw Scott, and published by the Institute of Metals, Caxton House, Westminster, S.W., from whom, or through any booksellers, copies can be obtained, price 21*s.* net.

THE Cambridge University Press has in the press, in the "Cambridge Travel Books" series, "The Earliest Voyages round the World, 1519–1617," and in the "Cambridge Public Health" series "The Spread of Tuberculosis," by Dr. L. Cobbett. The following books in the latter series are in preparation:—"Ticks as Carriers of Disease," Prof. G. H. F. Nuttall; "Serum Diagnoses," Dr. C. Browning; "Tropical Hygiene," W. J. R. Simpson; "The Purification of Water in Sedimentation, Filtration and Precipitation," Dr. A. C. Houston; "The Purification of Water by Ozone and Chlorine, and Domestic Filters," Prof. G. Sims Woodhead; "The Principles and Practice of the Dilution Method of Sewage Disposal," Dr. W. E. Adeney; "Disinfection," Dr. C. W. Ponder; "Housing in Relation to Public Health," Dr. C. J. Coleman; "School Hygiene," Dr. E. T. Roberts; "Soils, Subsoils, and Climate in Relation to Health," G. Walker; "Offensive and Harmful Trades," Sir T. Oliver; "Meat Inspection," Dr. W. J. Howarth and T. D. Young; "Vital Statistics," R. Dudfield and G. U. Yule; "Foods, Sound and Unsound," Dr. H. C. Haslam.

OUR ASTRONOMICAL COLUMN.

AN ASSOCIATION FOR THE OBSERVATION OF MARS.—During the past opposition of Mars, Prof. W. H. Pickering issued a series of monthly reports dealing with the planet; these were first published in *Popular Astronomy*, then reprinted, and distributed in pamphlet form; in this way a system of co-operation by correspondence was established. This proved so mutually advantageous that Prof. Pickering is now attempting to organise an association to operate during the coming opposition of next February. Details are given in a circular letter distributed with Mars Report No. 9. The particular advantage to be derived from collaboration is continuity of record, which can only be secured in this case by having observers uniformly distributed in terrestrial longitude in consequence of the small difference between the Martian and terrestrial days. Weekly drawings, reduced micrometric observations, if possible, and a monthly report are desired from each observer. Regular observation should begin next January, but observations of Syrtis Major in October, November, and December would be of exceptional interest.

THE POLE EFFECT IN THE IRON ARC.—Some results of further investigations carried on by Dr. St. John and Mr. Babcock, at the Mount Wilson Solar Observatory, in continuation of their important work on the minute differences of wave-length of lines in the spectrum of the iron arc when sources near the middle and near the negative pole are compared, have been communicated to the National Academy of Sciences, U.S.A. (Proc., vol. i., p. 295, 1915). It has been found that the wave-lengths of these sensitive lines are not affected by wide variations of *density* of the radiating vapour; change of *temperature* in the electric furnace does not affect the wave-lengths; with the enclosed arc the effect does not occur at pressures below 10 cm. of mercury; and, unlike the pressure shift, the pole effect does not appear to vary with wave-length. As the pole effect may amount to upwards of 0·02A, it is obviously important that it should be taken into consideration in re-determination of wave-lengths in international units. In order to eliminate the effect, the light should be taken from a point more than 2 mm. distant from the pole.

THE HARVARD OBSERVATORY.—Anything concerning this famous institution cannot fail to be of interest, and thus we welcome a reprint from the Harvard Alumni Bulletin, March 10, 1915, of two articles, one by the director, Prof. Pickering, and the other over the initials "J. D. M.," dealing with the observatory and its work respectively. Founded in 1840 by W. C. Bond, with the help of thirty subscriptions of 20*l.* each, the endowments now amount to 200,000*l.*, and the annual income exceeds 10,000*l.*, yet, we are told, "there has never been a time . . . when funds . . . were needed more than they are to-day." In addition to the well-known Arequipa Station in Peru, where the 24-in. photographic doublet has been mounted, a station in Jamaica has recently been founded for visual work. No fewer than seventy complete quarto volumes of Annals have been published and eight others are in preparation, whilst about 200 circulars have been issued. Concerning the progress of the Draper Catalogue, we are informed that down to March 1, 1915, Miss Cannon had classified no fewer than 188,350 stellar spectra.

ANNUAL REVIEW OF ASTRONOMY (1914).—M. P. Puiseux has contributed to the *Revue générale des Sciences* of July 15 another of the useful annual reviews we have learned to expect from his pen. In referring our readers to this article, attention may be especially directed to the reference under the heading "Comets" to Innes's cosmological hypothesis and the objection he raises that it leaves unexplained the fact of the small eccentricities and inclinations of the planets and satellites. In the section on nebulæ prominence is, of course, given to the application of

interferential methods to the study of the spectrum of the Orion nebula by Fabry, Buisson, and Bourget, work which, among many other interesting results, revealed the existence of the element of atomic weight 3, previously predicted on theoretical grounds by Prof. Nicholson.

MARINE BIOLOGY AT PLYMOUTH.

IN the latest number (vol. x., No. 4) of the Journal of the Marine Biological Association there are two papers of very considerable interest. Of these, the first deals with experiments in the rearing of plankton animals (Crustacean larvæ and Copepoda) which are of importance as a food supply for fish. The author is Mr. L. R. Crawshay. Plymouth Marine Station is justly celebrated for the invention by its director, Dr. Allen, of the method of rearing various types of marine larvæ by feeding them with pure cultures of the diatom Nitzschia. By this method the larvæ of Echinodermata, Mollusca, and Annelida have been reared until they attained the adult condition. Mr. Crawshay has endeavoured to extend the method to Crustacea. He has made some interesting discoveries. Thus he finds that in spite of sterilised water and abundant food, Copepoda live a very short time unless the culture flask be kept cool and the temperature remains constant. Then he finds that the harmful action of bacteria has been much exaggerated. There are only one or two varieties which are fatal to Copepoda, but these are of infrequent occurrence. When he had arranged for a good food supply and a constant temperature, he was able to keep the delicate pelagic form, *Calanus finmarchicus*, alive for months, and to rear the nauplii of Pseudocalanus through all stages of development until the attainment of the adult condition. When this method has been perfected it will be possible to study the life-histories of the economically important Copepoda in detail in the laboratory, instead of, as now, piecing the development together from scattered observations of plankton.

The second paper to which we wish to direct attention deals with twin larvæ of the starfish Luidia. These larvæ developed from eggs which were artificially fertilised at Plymouth. When the eggs had attained the blastula stage they were sent in sea-water in a thermos flask to the author, Dr. Gemmill, lecturer in embryology in the University of Glasgow, by whom they were reared further. Dr. Gemmill ascribes the formation of twins to the shaking which the blastulæ endured on the journey from Plymouth to Glasgow; this seems to have caused partial rupture of the blastulæ at a time when the tissues are equipotential, and the partially separated fragments have each striven to produce a perfect larva.

Besides these papers the volume contains a valuable list of the Annelida found in the neighbourhood of Plymouth by Dr. Allen. There is also a paper by Miss Olwen Rees, which we hope is the first of a series, which records the results of a systematic investigation of the internal anatomy of the British members of the Actinozoon family Sagartidæ. Too often accounts of the internal anatomy characteristic of a group have been founded on the dissection of a single "type" to the structure of which the other members have been assumed to conform.

At a time when the war threatens the continued existence of such celebrated stations as Naples and Trieste, it is important to be reminded of the asset which British zoology possesses in the Plymouth Station, and of the necessity of making every effort to sustain it during this arduous time.

E. W. M.

THE TAPPING OF RUBBER TREES.

THE Ceylon Department of Agriculture has issued a number of circulars on the tapping of individual and groups of Hevea trees and the effect of such operations on the storage of plant food. All the experiments and observations are based on *Hevea brasiliensis*, most of the trees dealt with being of considerable age. The papers are by Mr. T. Petch (mycologist) and by Mr. L. E. Campbell (rubber research chemist).

The first circular gives the results obtained by tapping one old Hevea tree for four years and nine months. The tree was planted in 1877, and is surrounded with other trees of the same species. It is a tree of an unusual type in so far that the main stem branches into two at about 10 ft. from the ground. In a way it is a famous specimen, and has been much photographed in past years. In four years nine months this tree has given 392 lb. 7 oz. of dry rubber: a most phenomenal crop. The rubber was obtained from the original and renewed bark on the basal portion of the stem.

The other circulars dealing with Hevea tapping results cover two distinct periods; first from 1911 to 1913 and second 1914. Experiments were made to determine the yield obtained by different frequencies of tapping and by different systems. Pricking and paring knives were also experimented with. The account of experiments for the period 1911–13 is largely statistical, very few deductions being drawn from the tabulated statements. The account of results for 1914 forms a continuation of those already referred to. While it would be too early to draw trustworthy practical conclusions from the results obtained, there are one or two points which become evident to the reader. They confirm previous results in so far that the yield per tapping increases as the time interval between consecutive operations is increased. The yield, however, in a given time is greatest with the more frequent tapping. It is further suggested that prolonged tapping on a single section, when cuts are 2 ft. apart, has a detrimental effect on the yield.

Reference is made to the fact now generally recognised that results of tapping experiments hitherto conducted are of little value because no count was taken of the varying capabilities of different tappers who do the work. In the circulars we now review this cause of variation was allowed for.

Mr. Campbell's circular on the effect of tapping on the storage of plant food in *Hevea brasiliensis* is exceptional in character. In tapping operations the living cortex of the tree is cut away in order that the latex may freely exude. This destruction of living tissue is made good by rapid cambium activity which soon results in the production of a thick renewed cortex, except in those cases where the tappers have damaged the cambium. The renewed bark is conceived to be formed largely at the expense of reserve foods in the plant. Mr. Campbell has selected the starch grains as a reserve food, the fluctuation in quantity of which might indicate the varying effects of tapping operations. The author made a study of the bark of tapped areas, and by an ingenious method determined the number of starch grains in a given area. The work indicates that the effect of careful tapping is localised. This is not in accordance with the general view on the subject. The local effects are especially apparent in a horizontal direction, and the author suggests that by changing tapping from one part of the tree to another at intervals the resting period of each area so tapped is nearly as effective as if the whole tree were rested. The "change over" system is becoming quite common on a number of Ceylon estates.

H. W.

ON BEAUTY, DESIGN, AND PURPOSE IN THE FORAMINIFERA.[1]

IN the dawn of history the Tartars in their flight before the victorious army of Ladislaus, King of Transylvania, scattered money as they fled, trusting to the apparently already established instincts of the Teuton soldiers that their pursuit would be thereby arrested. But King Ladislaus prayed that this money might be turned into stones, and his prayer was immediately granted. Hence the Nummulites. This, at any rate, is the account given of the matter in the sixteenth century by the learned Clusius,[2] and it is probably the first mention of the Foraminifera in print. The equally learned Strabo, however, had recorded that the Egyptian Nummulites were the petrified remains of beans left behind them by the builders of the Pyramids,[3] in spite of the explicit statement of Herodotus that the Egyptians never grew or ate beans in any form.[4] This Nummulite, which rightfully claims to be the earliest recorded Foraminifer, is also the highest and most complex of its order, and it was based upon his study of this family that Dr. Carpenter in 1885 claimed for the Foraminifera that they are the most highly specialised and structurally developed of the Protozoa.[5] "They stand at the summit of a long branch of the whole tree of

FIG. 1.—Section of Nummulitic Limestone.

life,"[6] and have with perhaps the single exception of the Globigerinidæ, played a more important part in the building up of vast tracts of the earth's surface than any other organism. The Nummulitic Limestones (Fig. 1) stretch in a broad band, in many places several thousands of feet in thickness, across Europe and Northern Africa, and through Asia by the Himalayas to China, the matrix, containing the perfect fossils, being a rock formed of their comminuted remains. The deposit is characteristic of the Eocene period; but the Nummulites have now died out, being represented to-day in the tropics by a single living species, *N. cummingii*.

Coeval with the Nummulites, and closely approximating to them in importance as world-builders, is the genus Alveolina, which is found in the same beds, either gradually replacing them, or sometimes taking their place with startling suddenness in the strata. Off the extreme point of Selsey Bill, in Sussex, the locally named "Mixon reef" rises at the summit of the Eocene deposits, composed almost entirely of fossil shells of *A. boscii* (Fig. 2), indistinguishable from the living shells of the species which abound to-day in the shallow water and littoral sands of Australian and other tropical shores.[7]

With all respect, however, to the recent utterances of its most noteworthy protagonist,[8] the Nummulite is a mere parvenu compared with the species *Spirillina groomii*, discovered in the Cambrian rocks of Malvern by Chapman,[9] and rediscovered by Arthur Earland and myself alive in the shallow waters of the west of Ireland,[10] which probably represents the earliest specific form of life to be found living at the present day. Even the conservative little Lingula shell has become slightly modified since its earliest ancestors wallowed in Cambrian mud a hundred million years ago.[11]

I have alluded to the Globigerinæ, which are to-day forming a geological deposit of unknown thickness over 48 millions of square miles in the modern oceans.[12] Agassiz has observed that "no lithological distinction of any value has been established between the chalk proper and the calcareous mud of the Atlantic,"[13] and it has been estimated that the time

FIG. 2.—*Alveolina boscii*, Defrance.

occupied by the deposit of the English chalk, arguing by the rate at which the Atlantic ooze is formed (which is about one foot in a century), must have been 150,000 years.[14]

As Maury has picturesquely said, "The sea, like the snow-cloud, with its flakes in a calm, is always letting fall upon its bed showers of microscopic shells."[15] These are some of the Foraminifera that

[1] From a discourse delivered at the Royal Institution on Friday, May 21, by Mr. Edward Heron-Allen.

[2] "Caroli Clusii et aliorum epistolae," Ep. xxxvii. Paris (c. 1550).

[3] Strabo, "Geographica," bk. xvii., cap. i., 34.

[4] Herodotus, "Euterpe," ii., 37.

[5] W. B. Carpenter, "On the Structure of Orbitolites." Journ. Quekett Micr. Club, ser. 2, vol. ii., p. 102.

[6] P. Chalmers Mitchell, Art. "Evolution" in "Encycl. Britannica," 11th ed., vol. x., p. 35. 1910.

[7] E. Heron-Allen and A. Earland, "The Foraminifera in their rôle as World-Builders." Journ. Quekett Micr. Club, ser. 2, vol. xi., pp. 9-11, 1913.

[8] R. Kirkpatrick, "The Nummulosphere." London, 1913, etc.

[9] F. Chapman, "Foraminifera from an Upper Cambrian Horizon of the Malverns." Q. Journ. Geol. Soc., p. 257. 1900.

[10] E. Heron-Allen and A. Earland, "The Foraminifera of the Clare Island District." Proc. R. Irish Acad., vol. xxxi. (Clare Island Survey part 64), p. 107, pl. ix., figs. 2, 3. 1913.

[11] Cf. E. Heron-Allen, "Selsey Bill." London, 1911, p. 24.

[12] Sir J. Murray, "The Ocean," p. 207. London, 1913.

[13] A. Agassiz, "Three Cruises of the *Blake*," vol. i., p. 150. London 1888.

[14] A. J. Jukes-Brown, "Handbook of Physical Geology," p. 130. London, 1884. The rate of deposition varies slightly according to depth. See Murray, *op. cit.*, p. 224.

[15] M. F. Maury, "The Physical Geography of the Sea," 15th ed., p. 322. London, 1874. Cf. H. N. Moseley, "Notes of a Naturalist on the *Challenger*," p. 582. London, 1879. "The dead Pelagic animals must fall as a constant rain of food upon the habitation of their deep-sea dependants."

may be washed out of any ordinary lump of Upper Chalk. In many localities on a smaller scale the Foraminifera may be seen occupied in this process of world-building. The shore of Dog's Bay, in Connemara, is composed of sands in which no grain of sand has a place. As far as the eye can see, and as deep as man can dig, preserving any measure of self-respect, the littoral deposit consists of pure Foraminifera extending far above high water-, and far below low water-marks. In a lesser degree the same thing may be seen a little to the north, just south of Emlagh Point, while anyone who has taken the trouble to examine the grit shed in disconcerting quantities by a new Mediterranean sponge must realise what masses of Foraminifera make up the bulk of the shallow water sands in those latitudes.

Such, then, shortly is the occurrence of the Foraminifera, which, leaving on one side the doubtful record of *Strombus lapidus* by Gesner in 1565,[16] which Prof. Rupert Jones identified as a Vaginulina,[17] make their first appearance in the Micrographia of Hooke in 1665[18] as "Figures observed in small sand." He figures one of them, which is clearly the common shore form *Rotalia beccarii*. In 1702 Prof. Plimmer's "Immortal Beadle,"[19] Antony van Leeuwenhoek, in a letter to the Royal Society,[20] figured the equally common and related form *Polystomella striato-punctata* "from out of the stomach of a shrimp," in which happy hunting-ground Reade recorded the presence of Foraminifera more than 150 years later.[21] There can be no doubt that they play an important part in determining the movements of many of our most important food fishes.[22]

Since the day of Leeuwenhoek the Foraminifera have continually engaged the attention of zoologists. Before Linnæus we have the works of Plancus,[23] Ledermüller,[24] and others, but between the time of Linnæus and the early years of the last century the era of monographs began; Walker and Boys in England,[25] Fichtel and Moll in Germany,[26] Lamarck in France,[27] Soldani in Italy,[28] have left behind them specialist works upon the Foraminifera which still form (sometimes to our serious embarrassment) the foundations of our study.

The recent period may be said to have commenced in 1819, when the father of Alcide d'Orbigny wrote to the geologist Fleuriau de Bellevue that his son was studying "microscopic cephalopods" from the shore sands at Esnandes, near their native town, La Rochelle.[29] After this, captains of ships and travelling naturalists supplied young d'Orbigny with a mass of material from all parts of the world, resulting in the publication of his Tableau Méthodique,[30] in which a vast number of species both recent and fossil were recorded. His records from Madagascar in particular are of supreme interest for us, for we have recently examined a series of dredgings from Kerimba, on the adjacent African coast,[31] in which we have rediscovered most, if not all, of his Madagascan species. He recorded in particular the species *Pavonina flabelliformis* (Fig. 3), which after 1826 was entirely lost sight of for half a century, when it was rediscovered in Madagascan sand by Brady.[32] It is quite one of the most beautiful of the Foraminifera, whether viewed as an opaque object or by transmitted light.

The true nature of the Foraminifera was not, however, understood until Dujardin in 1835[33] separated them from the Cephalopods, among which they had been grouped on account of certain superficial characteristics, and their extensile bodies. From this time onward the literature of the Foraminifera has expanded into a vast body of memoirs and monographs in every European language.[34]

The Foraminifera are to be found in all parts of the world and under all conditions, on the shore, in deep-sea soundings and dredgings, and floating at all depths of the ocean, whence they are taken in tow nets, and they divide roughly into two great classes, the Calcareous, which secrete from the surrounding waters a delicate and beautiful shell of carbonate of lime, and the Arenaceous, which build their shells out of sand-grains, sponge-spicules, and other fortuitous materials, often affording remarkable indications of phenomena of purpose and intelligence to which I shall presently refer. A single species, *Carterina spiculotesta*, builds its shell of fusiform calcareous spicules, secreted by the animal itself by a process which is at present entirely obscure. A remarkable feature of the organism is that whereas the resulting spicules on the upper surface follow the convolutions of the chambers, on the under side they are turned inwards so as to converge towards the central umbilicus.

FIG. 3.—*Pavonina flabelliformis*, d'Orbigny.

The distinction between the calcareous and arenaceous shells is purely artificial, isomorphs existing between the three great classes, the hyaline (or perforate), the porcellanous (or imperforate), and the sandy (or arenaceous). A typical isomorphism is represented by the three genera Cornuspira, which is porcellanous, Ammodiscus, which is arenaceous, and Spirillina, which is hyaline.

One of the most beautiful and delicate of the arenacea is *Reophax scottii*, which is built entirely of minute flakes of mica cemented together at the edges.

Polymorphina regina is a very handsome representa-

[16] C. Gesner, "De omni rerum fossilium genere, gemmis," etc. (Last sect., p. 165). Tiguri, 1565.
[17] T. Rupert Jones, Q. Journ. Geol. Soc., pl. xxxiv., fig. 5, *Vaginulina lacvigata*. 1884.
[18] R. Hooke, "Micrographia," p. 80. pl. v., fig. x. London, 1665.
[19] H. G. Plimmer, *Bedellus immortalis* (Presidential Address), J. R. Micr. Soc., p. 121. 1913.
[20] A. van Leeuwenhoek, "Sevende verfolg der Brieven," p. 196, pl. opp., p. 191, fig. 7. Delft, 1702.
[21] J. B. Reade, Trans. Micr. Soc., vol. ii., pp. 20–24. London, 1849.
[22] F. Pearcey, "On the Movements and Food of the Herring," Proc. Roy. Phys. Soc., Edinburgh, vol. viii., p. 389. 1885.
[23] Janus Plancus, "De conchis minus notis liber." Venice, 1739. 2nd ed., Rome, 1760.
[24] M. F. Ledermüller, "Mikroskopische Gemuths- und Augen-Ergötzung." Bayreuth, 1760–61.
[25] Walker and Boys, "Testacea minuta rariora." London, 1784.
[26] Fichtel and Moll, "Testacea microscopica." Vienna, 1798.
[27] J. B. de Lamarck, "Système des Animaux sans Vertèbres." Paris, 1801.
[28] A. Soldani, "Testaceographia." Senis, 1789–98.
[29] C. d'Orbigny, Journal de Physique, vol. lxxxviii., p. 187. Paris, 1819.
[30] A. d'Orbigny, "Tableau Méthodique de la Classe des Rhizopodes," Ann. Sci. Nat., vol. vii., pp. 245–314. Paris, 1826.
[31] E. Heron-Allen and A. Earland, "The Foraminifera of the Kerimba Archipelago," Trans. Zool. Soc. (Lond.), pt. i., vol. xx. (1914), p. 363; pt. ii. (1915). (In the press.)
[32] H. B. Brady, *Challenger* Reports, vol. ix., "Foraminifera," p. 375, pl. xlv., figs. 17–21. 1884.
[33] F. Dujardin, "Observations nouvelles sur les pretendus Céphalopodes Microscopiques," Bull. Soc. Sci. Nat. France, No. 3, p. 36. 1835.
[34] C. D. Sherborn, "A Bibliography of the Foraminifera." London, 1888.

tive of a genus which is frequently found attached to sand grains and shells by fistulose processes (Fig. 4).

The Globigerinæ, to which we have already alluded, are often merely stages in the life-history of *Orbulina universa*, which we may break open and find in it the earlier Globigerina.

Pulvinulina is represented by *P. pauperata* (Fig. 5).

The object and significance of this variety of beautiful forms are entirely obscure, but have engaged the attention of many biologists both in the Foraminifera and in the Radiolaria.[35] It must be remembered that a Foraminifer, like a Radiolarian, is a unicellular

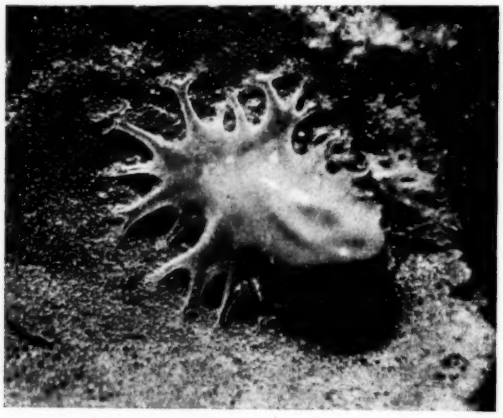


FIG. 4.—*Polymorphina rotundata*, d'Orbigny, fistulose and adherent.

animal consisting solely of a microscopic globule of undifferentiated protoplasm, vivified by a nucleus the functions of which are little understood, but which are essential to the existence of the animal.

This protoplasm is extended in the form of fine filaments which intermingle freely with one another, called pseudopodia, and their mechanical functions are locomotion and the capture of food. I have made a series of photographs of a fine Gromia which emerged from the mud in one of my tanks, climbed up the glass until it encountered a sea-weed stem, up which it crawled, and finally drew itself off on to the glass again by means of its pseudopodia. It then got lost,

FIG. 5. *Pulvinulina pauperata*, Parker and Jones.

but on punching a hole in a piece of black paper which was then gummed on to the glass and a strong beam of light directed through it, it came back into the circle of light, apparently indicating that these creatures are sensitive to light.

The other important function is the capture of food, which is caught outside the shell and usually drawn into it, as in this case of *Miliolina durrandii*, which has ingested a smaller Foraminifer and a diatom.[36]

[35] Cf. F. Gamble in Ray Lankester, "A Treatise on Zoology," pt. i., fasc. 1, pp. 130, 131. 1900.

[36] E. Heron-Allen, "Contributions towards the Study of the Bionomics of the Foraminifera," Phil. Trans. Roy. Soc. (Lond.) 1915.

It is a most significant, and at present unexplainable, fact that these minute protoplasmic globules secrete such varied materials for the formation of their shells from the surrounding medium as carbonate of lime, silica, and even sulphate of strontium, but the nature and character of their protoplasmic bodies which perform this function defies analysis or definition in the present state of our knowledge.

Their life-cycles have been carefully studied by Lister,[37] Schaudinn,[38] Winter,[39] and others, and the fact has been established that most, if not all, Foraminifera exhibit the phenomenon called dimorphism (that is to say, they start with a large or a small central chamber), and that the small-chambered (or microspheric) individuals reproduce themselves by means of amœbulæ expelled from the shells producing the megalospheric young, whilst the large-chambered (or megalospheric) individuals discharge flagellispores which conjugate with the flagellispores of other individuals and producing microspheric young, recommence or continue the life-cycle.

Within the last few months, owing to the initiative and manipulative skill of Mr. J. E. Barnard, a new and very striking method of investigation has been developed which not only reveals the internal structure of Foraminifera without the need of cutting sections, and so destroying the specimens, but may have far-reaching results when applied to the study of the living protoplasmic bodies. This is the application of the X-rays to the shells, the results of which operation are highly interesting and significant.[40] Here is a very thick and opaque species, *Biloculina bulloides*. The application of the X-rays reveals the internal arrangement of the chambers clearly. Here again is the coarse tropical calcareous form *Operculina complanata*, the whole of the interior septation of which is perfectly shown by the skiagraph. The process is especially valuable in connection with the arenaceous forms. Here is one of the most rugose species, and one which is exceedingly difficult to sectionise, owing to the sand-grains imbedded in the calcareous cement of which it is formed, *Cyclammina cancellata*. The skiagraph not only reveals its intricate labyrinthic interior, but here, as in the other species, reveals the fact that the individual is of the megalospheric stage of the life-cycle. The method is invaluable for the determination of doubtful species. The two species, *Jaculella obtusa* and *Botellina labyrinthica*, are externally very difficult to distinguish, but the skiagraph reveals the simple tubular cavity of the former as contrasted with the labyrinthic interior of the latter, and so determines the identity of the organisms.

You may rightly ask yourselves in what, beyond the beauty of the shells, consists the interest and value of the elaborate and concentrated study to which the Foraminifera have been subjected. Their value is both scientific and economic. They are the largest of the unicellular organisms—which are the closest to the beginnings of life—and if ever the structure and nature of protoplasm are to be determined, it will be, in my opinion, by the study of the Foraminifera that this conclusion will be arrived at. Economically they form the food of worms, starfishes, and many of the lower invertebrata, which in turn feed the food-fishes of the world.

I come now to the concluding and most important section of my discourse, which concerns itself with the phenomena of purpose and intelligence which I have

[37] J. J. Lister, "Contributions to the Life-History of the Foraminifera," Phil. Trans. Roy. Soc. (Lond.), vol. clxxxvi. B, pp. 401–453. 1895.

[38] F. Schaudinn, "Die Fortpflanzung der Foraminiferen," Wiegmann's Archiv. für Naturgeschichte, Jahrg. xlix., pp. 428–454.

[39] F. Winter, "Zur Kenntniss der Thalamophoren," Archiv für Protistenkunde, vol. vii. 1907.

[40] J. E. Barnard, "X-Rays in Relation to Microscopy," Journ. R. Micr. Soc., p. 1. London, 1915.

claimed to be exhibited by some of the Foraminifera in the construction of their shells, a claim which has been, and is, denied by several very distinguished zoologists, and admitted, with some reservations, by others no less distinguished.[41] There are limits to what is known, but I refuse to admit that there are limits to what is knowable. As Prof. MacBride has justly observed: "To put forward an unknown entity as the cause of phenomena which we cannot unravel is not to explain, but in reality to give up the attempt at explanation."[42]

The method in which the arenaceous Foraminifera collect and adjust the materials from which they build their marvellous shells is obscure, and though a light begins to dawn upon the process it would take too long to go into the matter on this occasion. Surface tension no doubt plays an important part in the operation, but surface tension will not account for the mysterious fact that certain species, such as, to take a single instance especially, *Haplophragmium agglutinans*, incorporate into their shells fragments of heavy gem minerals such as magnetite, garnet, and topaz, which are not by reason of their specific gravity to be found in the same sand-strata as the relatively light quartz-grains which are mainly used in the construction of the shell. The common *Verneuilina polystropha* of our shores exhibits this phenomenon also to a remarkable degree. It is, however, the intelligence (and I use this word with a full sense of the responsibility which I incur in using it) displayed in the manipulation of the material which compels the attention of the biologist. We are all familiar with the beautifully built tubes of the Caddis worm, and some of the marine worms build tubes of no less remarkable ingenuity, as, for instance, Amphictene, and one local variety of this worm constructs its tube as neatly as a bricklayer building a wall out of fragments of sponge-spicules of a carefully selected size. But these are Metazoa, higher animals, endowed with organs and senses. The Foraminifera, I must repeat for emphasis, are unicellular creatures without any differentiated organs or even structure of any kind whatever.

Take the common arenaceous form, *Psammosphaera fusca*, which builds itself into a roughly agglutinated house of sand grains. There is no selection here. There is none in the variety *P. testacea*, which uses only the shells of dead and living Foraminifera—it uses them because it has nothing else to use; but *P. parva* (Fig. 6), finding itself by its small size and free habit liable to suffocation in the ooze on which it lives, builds its house round a catamaran spar formed of a long sponge-spicule, which buoys it up upon the mud surface. Another species, *P. rustica*, builds in the spaces of a tent-pole arrangement of such spicules—several individuals frequently combining to form a mutually supporting mass. This creature fills in the triangular spaces between the main tent-poles with broken spicules of successively graduated lengths, and when it arrives at an awkward terminal space finds and incorporates a truncated triaxial sponge-spicule to fill in the angle.

It is when we come to the devices employed by the Foraminifera for their protection from living foes, or the forces of nature, that their purposive intelligence becomes the most phenomenal. Many of the larger and doubtless more succulent forms are peculiarly liable to attack from parasitic worms—an elaborate study of which has been made by Prof. Rhumbler.[43] A striking instance of this occurs in the case of *Crithionina pisum*, which has a softly agglutinated shell, which is often found (as in one of the specimens exhibited) bored by worms. Certain individuals have arrived at protecting themselves with a *chevaux de frise* of sponge-spicules, and these we never find, so far as our experience goes, suffering from these attacks. *Haliphysema ramulosa* is another easily attacked species, and it protects its aperture with a similar defensive apparatus. The same protective investment is assumed by *Hyperammina ramosa*, a species which ramifies in a most remarkable manner, so much so that Earland once constructed for me a Christmas greeting slide out of its many vagariant forms. (The "selection" in this case is rather that of Earland than of the Rhizopod.)

The genus Marsipella, of which the most familiar form is *M. cylindrica*, is built up of sponge-spicules set parallel to its axis, and is excessively friable, perfect specimens being very seldom found. It consists of a simple tube affording an easy prey to parasitic worms. It has consequently learnt to protect itself with a crown of spines, which keep out these intruders. But some individuals, to which we have given the specific name *M. spiralis*, have made the same discovery as did the prehistoric genius who invented string. They increase their power of resistance to shock by twisting their spicules into a left-handed spiral, by which means their power of resistance is enormously increased.[44]

But probably the zenith of purpose and intelligence is reached by the genus Technitella, a genus named by

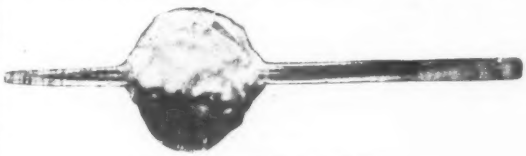


FIG. 6.—*Psammosphaera parva*, Flint.

Canon Norman—the Little Workman—with good cause. The most familiar species, *T. legumen*, builds its shell apparently of sponge-spicules set parallel to its axis. The accidental smashing of a specimen, however, revealed to us the fact that only the outer layer of spicules is thus disposed. The inner layer is set at right angles to the outer, thus producing the nearest approach to the woof and warp of a textile fabric possible in so rigid a material as sponge-spicules. This is clearly seen in a highly magnified fragment of a broken shell. The genus reaches its highest development of purposive selection, however, in our species *T. thompsoni*, which, out of the vast and heterogeneous mass of material at its disposition, selects only the anchor-plates of a particular kind of Echinoderm, which it cements together at their edges with an invisible cement, and thus constructs what is certainly one of the most decorative, and certainly the most highly perforated shell in existence.[45]

In the presence of the phenomena which I have exhibited before you this evening there are zoologists who aver that there is no such thing as purpose or intelligence to be postulated as a motive for the behaviour, not only of the Protozoa, but even of much higher orders of animal life. Jules Fabre, who has by consent assumed the purple among the historio-

[41] E. Heron-Allen, "On Purpose and Intelligence in the Foraminifera," Proc. Zool. Soc., p. 1069. London, 1914.
[42] E. W. MacBride, in NATURE, vol. xciv, p. 304, November 19, 1914.
[43] L. Rhumbler, "Beiträge zur Kenntniss der Rhizopoden," Zeitschr. Wiss. Zool., vol. lvii., p. 580. 1894.
[44] E. Heron-Allen and A. Earland, "On some New Astrorhizidæ and their Shell Structure," Journ. R. Micr. Soc., p. 382. 1912.
[45] E. Heron-Allen and A. Earland, "On a New Species of Technitella from the North Sea," Journ. Quekett Micr. Club, ser. 2, vol. x., p. 403. 1909.

graphers of the insect world, denies intelligence even to the Digger Wasps, and to the Termites of Ceylon—at the end of all his amazing observations he says, "*Ils ne savent rien de rien.*" I prefer to go back exactly half a century to when Philip Henry Gosse, F.R.S., than whom no keener observer of marine organisms ever lived, said, "The more I study the lower animals, the more firmly am I persuaded of the existence in them of psychical faculties, such as consciousness, intelligence, and choice, and *that* even in those forms in which as yet no nervous centres have been detected."[46] A distinguished critic, Dr. Chalmers Mitchell, tells me that I might as well claim intelligence and purpose for such plants as the Tragopogons, the seeds of which are fitted with a parachute, which enables them to travel to new pastures. I almost wonder that I am not accused of agreement with the whimsical suggestion of Samuel Butler, who looked forward to the day when we should see little engines playing about the doors of the engine sheds, whilst the parent engine smoked peacefully inside. I refuse to admit that the seed parallel has any bearing upon the case. I am dealing with the utilisation of independent materials collected by the Foraminifera for a specific purpose. In the case of the seeds it is a development of a useful integral part and a consequent "survival of the fittest"—but if a bean in the kitchen-garden were to attach to itself the parachute of a Tragopogon and fly over the wall when in danger of its life at the hands of the cook, *that* would be an exercise of purpose and intelligence comparable with the phenomena which I have exhibited this evening.

An evolutionary cycle is *ex-hypothesi* continuous, and I refuse to allow a consistent evolutionist to postulate a discontinuity in his evolutionary cycle—he cannot at some unknown point introduce into his bioplasm an outside and novel influence to which he gives the name of "Intelligence." I claim that every living organism living an independent existence of its own is endowed with the measure of *intelligence* requisite to its individual needs.

We must accumulate facts, we must assimilate phenomena, we must strive after a comprehension of motive forces. To quote Prof. MacBride once more: "The use of hypotheses which assist in binding together the facts observed in the behaviour of living things, and in elucidating the laws which govern them . . . may be regarded as neither vitalistic nor mechanistic, but as plain common-sense applications of the indicative method. In this way only it seems to me we shall ever make progress with 'explanations' of the phenomena of life, for all 'explanation' in the last resort consists merely in putting together similar things."[47]

But to arrive at a conclusion we must study the life-history of these lowly organisms, which, as Prof. Verworn has said, seem to be especially provided for the biologists, since of all living creatures they are nearest to the origin of life. We must not merely collect and classify them like postage stamps. The study of the Foraminifera has been grievously afflicted with a tendency to lie upon a platform between two points, on one of which sits the invalided Man of Science who, forbidden by his doctor to work, has bought a pound of the comfit known to our youthful taste as "Hundreds and thousands," and who employs his time sorting out the red, the white, and the blue, setting aside as new species those globules which have been damaged in the process of manufacture—and on the other of which sits the Grammarian, whose sole regret upon his deathbed was that he had not devoted the whole of his life to the dative case.

[46] P. H. Gosse, "A Year at the Shore," p. 247. London, 1865.
[47] E. W. MacBride, in NATURE, vol. xciv., p. 304, November 19, 1914.

GEOGRAPHY OF BRITISH FISHERIES.

IN a paper entitled "Geography of British Fisheries," published in the *Geographical Journal* for June, Prof. J. Stanley Gardiner discusses the deep-sea fishing industry, trawling, and drifting, which has an annual value of upwards of fifteen million pounds. The main points of the paper are here summarised.

There are about 3000 first-class fishing vessels, of which the trawlers work from the White Sea to the Moroccan coast, wherever depths of fewer than 200 fathoms are found. Off Spain, Portugal, and Morocco their existence depends on the limit of territorial waters not being increased beyond three miles. What Prof. Gardiner is more especially concerned with are the habits of the fishes, their growth and reproduction, in so far as they are affected by the physical conditions of the waters in which they live. It is this correlation of habits with physical conditions that is essentially the geography of living animals. Not only have the adult fish to be considered, but also their eggs, their larval stages, and the eggs, young, and adults of all the lower animals and plants on which they feed.

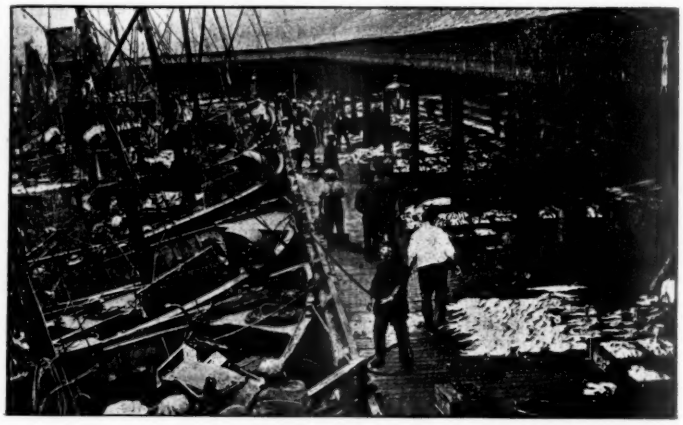


FIG. 1.—Aberdeen Fish Wharf.

Currents merit particular attention, for the eggs and (or) young of practically all our food fishes are passively distributed by their agencies. Currents are best ascertained by regular observations on the temperature and salinity of the fishing waters, which are divided into oceanic and coastal zones, the former with relatively uniform conditions, the latter subject to great seasonal changes. A further division is into Atlantic and Arctic regions, our edible fish all belonging to the former, and following its waters in the summer as they push back the Arctic ice. There is, however, considered to be an intermingling of boreal

and "Mediterranean" forms, once separated by a land ridge from Scotland to Iceland.

All fish ultimately depend on plant-life for their food. In the ocean floating plants are all-important, minute unicellular organisms living in incredible numbers in the upper layers of the water, in suitable conditions daily multiplying themselves, giving a fertility to the sea many times that of the best soil. The cycle of life of such pelagic plants in the open ocean is simple, complicated only by fluctuations in sunshine, rainfall, and other meteorological conditions. In coastal waters, especially where broad shelves extend out from the land, such fluctuations are more considerable, and often enormous seasonal changes in temperature and salinity have to be added. Instead of the same species of plants all the year round, and in consequence of the smaller animals which feed upon them, there may be a whole series of species, each suitable to some particular phase of seasonal change. Form succeeds form, the old form disappearing, perhaps passing into resting stages upon the bottom, until suitable physical conditions bring them once more into active life. It seems possible that this very destruction and re-creation adds further to the total food of our seas. The peculiar richness of the fishing grounds is, however, mainly ascribed to the abundant land-drainage of western Europe with its teeming population, to this being due much of the nitrogen, phosphorus, and silica in forms available for living organisms.

FIG. 2.—Floating plants, mainly Ceratium.

Most fish are bottom-feeders, and the ground must be suitable to the animals upon which they feed. Mud, the deposition of which implies the absence of movement, is inimical to all life. Flat fishes are themselves only suited to sand, on which they rest, invisible to their enemies. The cod and haddock prefer respectively rock and sand, but the hake, ling, coalfish, and whiting, belong to a family of such remarkable adaptability in feeding that it is of vast economic importance. The herring deposits its spawn on rocky ground, so that its eggs get well aerated and are not silted over, but most other economic fishes have floating eggs.

As examples the plaice, cod, herring, mackerel, and eel are chosen. Each has its own spawning grounds, its optimal depth, salinity, and temperature at each period of its life, its own wanderings in search of food, etc., and its own peculiar development. The plaice has its southern limit at the isotherm 10° C. The North Sea stock spawns in February, principally off our coasts between Dover and Cromer, and the eggs and young require to be carried by the currents so that the latest larval stages fall on the bottom in not too great intensity in a few feet of water, which must have a salinity of at least 0·017. Naturally the Dutch coast is the great plaice nursery, and from here the young fish gradually disperse into deeper and deeper waters, at the same time becoming more suitable to the food they produce, until in their fourth season they undertake their first breeding migration. The eggs, which are somewhat corrugated, have been found carried into the Baltic in undercurrents of warmer Atlantic water, a phenomenon considered to be correlated mainly with viscosity. Growth is a matter largely of temperature and salinity. Thus in the North Sea a fish of 40 cm. long is six years old, as shown by its otoliths, and in Barents Sea (White Sea) about eighteen. The latter rate of growth is found in the brackish Baltic, where 40 cm. and eighteen years are about the limits as contrasted with 70 cm. and fifty years in Barents Sea.

The herring is a feeder on the floating life of the sea, and rises and falls in the water by night and day, shunning the light. It exhibits somewhat similar rates of growth to the plaice as shown by its scales, which form broad, transparent growth-bands in summer as contrasted with narrow, opaque bands in winter, the fish not shedding its scales during its life. By the study of the breadths of the summer bands the areas where fish spent their previous lives may be ascertained, and thus breeding shoals may be analysed. Maturity is reached in different localities in from three to ten years. The spawn is laid on the bottom and at 3° C. hatches in forty days, at 12° C. in eight days. The young are at the mercy of the currents, and good years off Norway are considered to be those in which spawning is late, the currents being more determined and the sea having abundance of minute and suitable plant-life as food.

Prof. Gardiner concludes with a plea for the continuation after the war of the International Council for the Exploration of the Sea, which came into existence in 1902. Any control of the West European fisheries must be by international agreement, for which, as he says, there must be a foundation of incontestable evidence. The conferences of the representatives of the twelve countries on the International Council have been highly profitable in the investigations of the economic conditions of fisheries, depend-

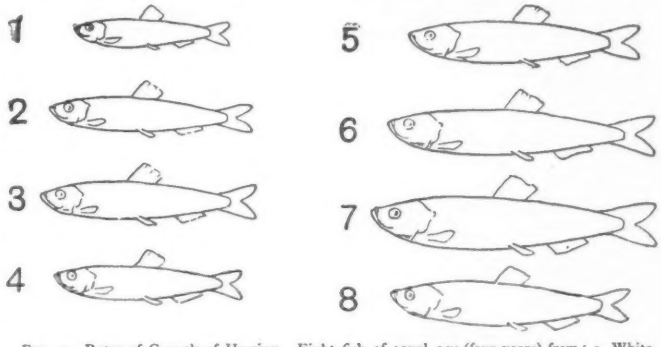


FIG. 3.—Rates of Growth of Herring. Eight fish of equal age (four years) from: 1, White Sea; 2, Lysefjord, Norway; 3, Zuyder Zee; 4, East Coast of Sweden; 5, West Part of North Sea; 6, Atlantic Ocean; 7, Iceland; 8, West Coast of Norway (Spring Herring). (*After Hjort*).

ing as these do on immense and fundamental scientific problems. Any fishery agreement is useless unless all neighbouring countries are signatories, and the matter is one of the food of a vast number of the human race. Furthermore, in the extension of such international institutions lies the best hope of permanent peace.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Albert C. Seward, professor of botany in the University, has been elected master of Downing College, in succession to the late Prof. Howard Marsh.

THE Medical College of the University of Cincinnati received several large donations during July. We learn from *Science* that Mrs. Mary M. Emery promised the University the sum of 50,000*l.* for a new medical college building, on the condition that an additional 50,000*l.* be raised by July 1 for its equipment and maintenance. At the appointed time, Dean C. R. Holmes, of the College of Medicine, announced that the 50,000*l.* had been secured. The sum of 6000*l.* has just been raised by citizens of Cincinnati for the purpose of maintaining for three years a chair of medicine in the Medical College. The chair will be known as the Frederick Forchheimer chair of medicine, in honour of the late Dr. Frederick Forchheimer, who was for years professor of medicine at the Medical College.

THE new metallurgical buildings at the University College of South Wales and Monmouthshire, Cardiff, were formally opened on Monday, July 26, by Sir Clifford J. Cory, Bart., M.P. The building which has been erected forms an important addition to the present department of metallurgy, and provides accommodation for assaying, analysis of fuels, metallography, and photomicrographic work, lecture theatre, professors' private room, balance- and reading-rooms, etc. The laboratories are of considerable size, lofty, well lighted and ventilated, and contain the most modern and up-to-date equipment for teaching these branches of metallurgy. The erection of this new building is due to the generosity of the South Wales and Monmouthshire Coalowners' Association, in acknowledging which, Prof. Read directed attention to the fact that to enable the college to help, as it should, the industrial progress of the works in the district, provision would have to be made in the near future for putting down experimental furnaces for smelting and other operations, so as to be able to provide a thorough practical training for metallurgical students.

THE Department of Technology of the City and Guilds of London Institute has issued through Mr. John Murray, Albemarle Street, London, W., at the price of ninepence net, its programme for the session 1915–16. The programme contains the regulations for the registration, conduct, and inspection of classes, the examination of candidates in technological subjects, and the award of teachers' certificates in manual training and domestic subjects. We notice that the syllabuses in both coal-tar distillation and intermediate products and in electro-metallurgy have been revised, that in boot and shoe manufacture has been redrafted, and the revised syllabus in mechanical engineering issued separately last session is now included in the programme. The conditions governing the award of full technological certificates in painters' and decorators' work, cabinet-making, bookbinding, and embroidery have been modified, and the lists of works of reference have been revised. The department now examines in more than eighty separate branches of technology, and the constitution of the examinations board, the representative character of the panel of consultative examiners, and the large number of practical men among the acting examiners, all provide convincing evidence of the pains taken by the executive committee to ensure that thoroughly practical teaching, based consistently upon sound scientific knowledge, shall be given in the technical institutions throughout the country.

THE Board of Education has issued its Regulations for Technical Schools, etc., in England and Wales for the session 1915–16. They are not, except for minor matters, materially different from those of last year. The arrangement as to the payment of a fixed, or inclusive (as it is now termed), annual grant in respect of any efficient school occupying a definite educational place in the area and providing approved courses of instruction covering five or more years, is now extended to apply to senior or advanced courses, and the Board will also under certain conditions pay an inclusive grant to a local authority in respect of all courses carried on under its direction for the year 1915–16, and grants may be paid for the year 1914–15 calculated upon the same basis. Examinations upon the courses of study must be held by the teachers in each year, and in the final year an external assessor must be associated with the teachers, but other arrangements may be approved for students taking senior part-time courses. Certain new conditions are attached to the endorsement of certificates. The onerous condition still remains in the regulations for junior technical schools whereby the pupil must enter upon the employment for which the school provides, thus debarring a clever pupil from entering upon the advanced courses of a higher technical school, and recognition will be refused to a school unless the pupils so enter. Classes in university tutorial courses may be duplicated so as to enable artisan students to attend the one or the other, and arrangements will be approved for special advanced courses of instruction, where adequate provision exists for tutorial classes of the ordinary standard, for students who have passed through the three years' course satisfactorily. The exigencies of the war have caused the Board to sanction short courses suitable for recruits, and for housewives in economical cookery.

IN October next the *Athenaeum* proposes to start a subject index to periodicals as a regular monthly issue. The index is to embrace bibliography, theology, philosophy, sociology, geography, history, the fine arts, *belles-lettres*, and the science of everyday life. Pure science, law, and medicine will not be included. A preliminary notice of the scheme appeared in the issue of our contemporary for July 3, and specimens of the proposed lists have been given in succeeding issues in the form of an index to publications relating to science and technology, with special reference to the war. A very large number of cross-references make it easy to find one's way about the index already published. The *Athenaeum* proposes to index more than two hundred periodicals—English, American, and Continental—with occasional selections from a much wider field. We imagine it will be found extremely difficult to decide which periodicals are to be favoured by inclusion among the two hundred. The short specimen index published already contains references to more than sixty periodicals. The International Catalogue of Scientific Literature, which has been indexing the literature of science for the past ten or twelve years, indexes not fewer than 8000 periodicals. So long as authors continue to publish important papers in little-known periodicals, it will be impossible to produce a complete index without taking the less

important journals into consideration. If all who are engaged in preparing general subject-indexes were to agree as to which periodicals should be indexed, and were to publish beforehand the names of the periodicals they proposed to index, it is possible that such action might have influence upon authors who have not yet decided where they should publish. Unfortunately the periodicals excluded from the list will immediately show cause why they should be included. We have no doubt that the *Athenaeum* will find a way of dealing with this difficulty, and we wish our contemporary success in its new undertaking.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, June 28.—Dr. Peach, F.R.S., vice-president, in the chair.—Prof. J. W. **Gregory**: Contributions to the geology of Benguella and some Cretaceous Echinoidea from the north of Lobito Bay.—G. W. **Tyrrell**: Notes on rocks obtained in Angola by Prof. Gregory.—R. B. **Newton**: Some Cretaceous shells from Angola.—G. C. **Crick**: Some Cephalopoda from Benguella.—Mrs. Margaret F. **Romanes**: Notes on an Algal Limestone from Angola. These six connected papers were based on the visit in 1912 of Prof. Gregory to Angola and Benguella, Portuguese West Africa, and on the material collected and brought home by him. The earliest explorers of this region were Livingstone, who described the chief features of the physiography, and Cameron, who discovered Cretaceous rocks as well as widespread distributions of granite and gneiss. The Cretaceous rocks begin on the coast and end inland in great conglomerates at the floor of the old plateau of gneiss. The following conditions were recognised and described: Bihé Sandstones consisting of soft beds giving rise to the wastes known as the "hungry country"; Oendolongo sandstones, rhyolites, and tuffs, often like the Old Red Sandstone, referred by some to the Devonian, by others to the Torridonian; Lepi greywackes with cherts, tuffs, and slates; Huambo Quartzites, pre-Torridonian. The coast is traversed by numerous step faults, cutting through the Cretaceous rocks. The fossils of these rocks are described by R. B. Newton. A number of the species are new to the area.—W. F. P. **M'Lintock**: The zeolites and associated minerals from the tertiary lavas around Ben More, Mull. The peculiar facies of vesicle-minerals in a belt of lavas traceable from areas free from contact metamorphism up to the margin of one of the big acid intrusions is described. The non-metamorphosed rocks are albitised olivine basalts, in which the olivine is completely, and the augite partially, chloritised. The vesicles are filled with chlorite, albite, epidote, prehuite, and scolecite deposited in the order named. Frequently these minerals are seated upon a coarsely crystalline layer of albite, augite, magnetite, and chlorite, with which the vesicle is lined, and it is concluded that the cavities were filled during the cooling of the lava. By contact metamorphism the contents of the amygdales of the lavas around the margins of the intrusion have been altered; the chlorite has gone to hornblende, the scolecite to prehnite, epidote, and ultimately to garnet; the prehnite, to epidote and garnet; whilst the epidote is replaced by garnet and aphene. The effect of the metamorphism has been generally to build up the minerals in the reverse order to that in which they were originally deposited in the vesicles.—R. C. **Mossman**: A see-saw of atmospheric pressure, temperature, and wind velocity between the Weddell and Ross Seas. By a comparison of the departures from the normal for each of these data during the years 1902–4, 1910–12 evidence was obtained of an opposite phase relationship or see-saw of meteorological conditions over these seas. The discussion formed part of a much wider inquiry into the meteorology of antarctic regions.—W. J. **Walker**: The magnetic quality of iron and steel as affected by transverse pressure. The compressing force acted perpendicular to the direction of magnetisation. The induction was measured ballistically. The general result was diminution of susceptibility with increase of transverse pressure; but there were variations from this general result which demanded further investigation.—W. **Hill**: Chalk boulders from Aberdeen and fragments from the sea-floor off the Scottish coast; and notes on the structure of the chalk occurring in the west of Scotland. These important papers were found among the author's possessions after his death.—Prof. E. **Topsent**: Supplementary paper on the sponges collected by the Scotia Scottish National Antarctic Expedition.—Dr. R. **Kidston**: The fossil plants of the Forest of Wyre and Titterston Clee Hills coalfields. With remarks on the geology of the coalfields by T. C. Cantrill and E. Dixon.

PARIS.

Academy of Sciences, July 26.—M. Ed. Perrier in the chair.—G. **Bigourdan**: The unpublished correspondence of the astronomer, J. N. Delisle.—J. **Boussinesq**: The importance of the rudimentary dynamics of Aristotle in the progress of Mediterranean civilisation.—C. **Gutton**: An induction balance designed for the detection of buried shells in ground under cultivation. Owing to the danger to agriculturists due to the presence of unexploded shells buried in the soil and the liability of explosion owing to contact with a plough, the author has devised a modification of the Hughes induction balance by means of which two persons can thoroughly explore a hectare of land in about three hours.—J. **Maldiney**: The retarding action of sugar in the development of photographic negatives and the permeability of gelatine to the metolhydroquinone developer, used alone or with sugar. A plate giving a complete image in five seconds under the influence of the developer alone can be retarded by the addition of sugar, the addition of 60 grams of sugar per 100 c.c. of developer causing a retardation of from three to five minutes. The action appears to be due to physical causes, the increased viscosity of the solution rendering the penetration of the gelatine emulsion slower.

WASHINGTON, D.C.

National Academy of Sciences, July 15 (Proceedings No. 7, vol. i.).—W. S. **Adams** and F. G. **Pease**: Nova Geminorum No. 2 as a Wolf-Rayet star. A continuous series of observations on Nova Geminorum No. 2 has shown the development of the spectrum of this star through the successive stages characteristic of novæ into one very strongly resembling that of planetary nebulæ; and then, by the gradual elimination of the nebular lines and their replacement by Wolf-Rayet bands, into a spectrum identical with this characteristic type of stellar spectra.—A. A. **Michelson**: The ruling and performance of a 10-in. diffraction grating. A 10-in. grating (actual ruled surface 9·4 in. by 2·8 in.) having a theoretical resolving power of about 660,000, shows an actual power of about 600,000. The methods of obtaining exact ruling is also discussed.—E. E. **Barnard**: A singular dark marking on the sky. From a dark object in Cepheus and those in Taurus the author gets the impression that the interstellar spaces are suffused with a feeble nebulosity and that the dark marks are due to the projection upon this background of nearer dark, opaque objects.—A. L. **Parson**: A highly sensitive electrometer. The principle of working in a condition approaching instability is used to increase greatly the sensitiveness

of electrometer, and obtain an instrument theoretically sensitive enough to detect 10^{-6} volts (though unsteadiness makes it as yet impossible to detect an isolated potential-difference of less than 3×10^{-5} volts).—C. **Wissler**: The distribution and functions of tribal societies among the plains Indians: a preliminary report. Field-work conducted by the writer and his associates in the American Museum of Natural History leads to the conclusion that the societies have spread from tribe to tribe by culture diffusion of a desultory kind; that certain features of organisation are traceable to particular tribes, and no one tribe can be the originator of the society system as a whole.—T. W. **Richards** and L. B. **Coombs**: The determination of surface tension. Attention is directed to various sources of error in the measurement and in the calculation of surface tension by the capillary-tube method, an improved form of this method is described, a new correction for the meniscus is proposed, and exact measurements with a number of liquids are presented.—Ales **Hrdlička**: An exhibit in physical anthropology. The exhibits prepared under the direction of the author for the Exposition at San Diego are described briefly to indicate their breadth, their permanent value, and their capability of forming the foundation of an anthropological centre.—T. W. **Richards**: The compressibilities of the elements and their relations to other properties. This paper records all the recent work on the compressibility of the elements performed at Harvard, reduced to the best available standard—the newly-determined compressibility of mercury. It is pointed out that the reciprocals of the melting points are very closely associated with the coefficients of expansion, and that both these properties seem to be essentially connected with atomic volume and compressibility.—E. B. **Frost**: Radial velocities within the great nebula of Orion. We must alter our conceptions of the nebula as an enormous mass of quiescent gas, and regard it as seething with local whirlpools, besides perhaps having a considerable motion of rotation as a whole.—W. S. **Adams**: The radial velocities of the more distant stars. The radial velocity of stars increases rapidly with the proper motion, and only very gradually with the spectral type. This agrees with Eddington's hypothesis that the relation between velocity and spectral type may be a relation between velocity and distance.—T. H. **Morgan**: Localisation of the hereditary material in the germ-cells. The chromosomes not only furnish a mechanistic explanation of Mendelian heredity, but in the case of non-disjunction and in the case of the point by point correspondence between the linkage groups and the chromosomes, furnish a verifiable explanation of the results. In the case of crossing-over and of interference the chromosomes give us the only objective explanation of the results that has been as yet offered.—G. P. **Merrill**: Researches on the chemical and mineralogical composition of meteorites. Abstract of extensive investigations which will appear as a memoir in the series of Memoirs of the National Academy.—W. B. **Ford**: The representation of arbitrary functions by definite integrals. The function $f(x)$ is represented as the limit of a definite integral depending on a parameter when the parameter becomes infinite, or by a series of definite integrals.—J. B. **Murphy** and J. J. **Morton**: The lymphocyte as a factor in natural and induced resistance to transplanted cancer. A marked increase in the circulating lymphocytes occurs after cancer inoculation in mice with either a natural or induced immunity. When this lymphoid reaction is prevented by a previous destruction of the lymphoid tissue with X-ray the immune states are destroyed; hence the lymphocyte is a necessary factor in cancer immunity.—W. D. **MacMillan**: Some theorems connected with irrational numbers. The presence of the factors $i-j\gamma$ in the denominators of series rising in celestial mechanics does not affect the domain of convergence of the series, provided γ is a positive irrational number which satisfies a rather mild condition.

BOOKS RECEIVED.

Descriptive Geometry. By H. W. Miller. Third edition. Pp. 149. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6s. 6d. net.

Fighting the Fly Peril. By C. F. Plowman and W. F. Dearden. Pp. 127. (London: T. Fisher Unwin, Ltd.) 1s. net.

Fungoid Diseases of Farm and Garden Crops. By Dr. T. Milburn. Pp. xi+118. (London: Longmans and Co.) 2s. net.

Alcoholometric Tables. By Sir E. Thorpe. Pp. xiv+91. (London: Longmans and Co.) 3s. 6d. net.

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology. Vol. ii., No. 5. Nemertinea. By H. A. Baylis. Pp. 113–134+2 plates. (London: Longmans and Co,, and others.) 2s. 6d.

Catalogue of the Mesozoic Plants in the British Museum (Natural History). Part vi. The Cretaceous Flora. Part ii. Lower Greensand (Aptian) Plants of Britain. By Dr. Marie C. Stopes. Pp. xxxvi+360+xxxii plates. (London: Longmans and Co., and others.) 21s.

CONTENTS.

	PAGE
A Chapter of British Science. By E. R.	611
The Principle of Relativity	612
The Development of Man	613
Mathematical Crystallography. By L. J. S.	614
Our Bookshelf	614
Letters to the Editor:—	
Palæolithic Man in South Africa. (*Illustrated.*)—F. W. Fitzsimons; Prof. Arthur Keith, F.R.S.	615
Surface Tension and Ferment Action.—Dr. Horace T. Brown, F.R.S.	616
The Cancer Problem and Radio-activity.—H. C. Ross; Prof. J. Joly, F.R.S.	617
The Magnetic Storm of June 17 and Solar Disturbances.—Rev. A. L. Cortie, S.J.	618
Science and Food-Supply.—Alexander Graham Bell	618
The Promotion of Research by the State	619
Modern Processes of Manufacturing Hydrogen for Airships	620
Science, Museums, and the Press	621
Exploration in the Karakorum. By T. H. D. L.	622
Notes	622
Our Astronomical Column:—	
An Association for the Observation of Mars	628
The Pole Effect in the Iron Arc	628
The Harvard Observatory	628
Annual Review of Astronomy (1914)	628
Marine Biology at Plymouth. By E. W. M.	629
The Tapping of Rubber Trees. By H. W.	629
On Beauty, Design, and Purpose in the Foraminifera. (*Illustrated.*) By Edward Heron-Allen	630
Geography of British Fisheries. (*Illustrated.*)	634
University and Educational Intelligence	636
Societies and Academies	637
Books Received	638

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